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Volume 3

EPA

The IJC Menomonee River Watershed Study

Surface Water Monitoring Data

Menomonee River ★

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's effort involves the search for information about environmental problems, management techniques, and new technologies through which optimum use of the nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

The Great Lakes National Program Office (GLNPO) of the U.S. EPA, was established in Region V, Chicago to provide a specific focus on the water quality concerns of the Great Lakes. GLNPO also provides funding and personnel support to the International Joint Commission activities under the U.S.- Canada Great Lakes Water Quality Agreement.

Several land use water quality studies have been funded to support the pollution from Land Use Activities Reference Group (PLUARG) under the Agreement to address specific objectives related to land use pollution to the Great Lakes. This report describes some of the work supported by this Office to carry out PLUARG study objectives.

We hope that the information and data contained herein will help planners and managers of pollution control agencies make better decisions for carrying forward their pollution control responsibilities.

Madonna F. McGrath
Director
Great Lakes National Program Office

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The quality of runoff from nine mainstem river stations and three inner harbor stations were monitored between 1975 and 1977. Automatic flow recording and water sampling instruments were used at the mainstem river stations. Seasonal flow and concentration data for 26 parameters monitored throughout the study are documented, although discussion is focused on the key parameters--suspended solids, total- and soluble-P and lead--to demonstrate seasonal and site differences. Bacterial counts and PCB concentrations determined sporadically are also included. Evaluation made on the concentration data includes 1. comparison with water quality criteria, 2. correlation to show relationships between parameters and 3. behavior of parameter concentration and loading rates during an event.

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PREFACE

The main thrust of this volume is to present a documentation of a 3-year monitoring program designed to assess kinds and amounts of pollutants arising from land drainage of mixed and predominantly single land uses in the Menomonee River Watershed. Data are summarized on seasonal, annual and unit area bases which include estimates of variances. Although numerous parameters were determined, discussion is focused mainly on the principal parameters of concern in the Watershed, i.e., suspended solids, total- and soluble-P and lead, to illustrate behavior and magnitude of contaminants during runoff events, seasons and years. Major factors affecting loadings of these key parameters are indicated.

As part of this volume, data of the benthic macroinvertebrate surveys are presented and evaluated in an attempt to establish a biological indicator of pollution.

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*Part III The Benthic Macroinvertebrates of the Menomonee River . III-i

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*Detailed contents are presented at the beginning of each part.

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PART I

QUALITY OF RUNOFF FROM MIXED LAND USES

by

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Abstract

The quality of runoff from nine mainstem river stations and three inner harbor stations were monitored between 1975 and 1977. Automatic flow recording and water sampling instruments were used at the mainstem river stations. Seasonal flow and concentration data for 26 parameters monitored throughout the study are documented, although discussion is focused on the key parameters--suspended solids, total- and soluble-P and lead--to demonstrate seasonal and site differences. Bacterial counts and PCB concentrations determined sporadically are also included. Evaluation made on the concentration data includes 1. comparison with water quality criteria, 2. correlation to show relationships between parameters and 3. behavior of parameter concentration and loading rates during an event.

Seasonal events and baseflow loads for four parameters estimated by a stratified random sampling model enhanced by a ratio estimator are presented. The most important hydraulic and land use activity factors affecting variation in loading from one tributary area to another are discussed. These factors either affect generated runoff or pollutant concentrations. Remedial measures should be based on controlling land use activities which result in high pollutant concentrations, and towards those areas which because of such hydraulic characteristics as high connected imperviousness, generate persistently high pollutant loadings.

Rainfall-runoff relationships and occurrence of first flush were also analyzed.

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I-1. INTRODUCTION

The river monitoring stations were established to determine the types and amounts of water pollutants reaching the Menomonee River and its principal tributaries. Emphasis was placed on the collection of samples during runoff events. Because these stations are located on the mainstem of the river they integrate drainage from all land use activities tributary to that station. In contrast, Part II of this volume exhibits monitoring data for drainage of areas in a predominantly single land use. In this way it is possible to compare loadings for relatively large areas containing mixed land uses while evaluating single land use impacts in those areas. This volume deals only with a description of the monitoring activities and the data found. Subsequent volumes (4, 5 and 6) will deal with the interpretation of this data by various modeling and other methods.

The data outlined in Part I were collected during the period January 1975 to November 1977.

I-2. CONCLUSIONS

Mean seasonal baseflow and event flow and concentration values fluctuated between seasons for each station and between stations during a season. The trends in mean event concentrations between seasons for all stations, as illustrated by the key parameters, reveal that 1. suspended solids levels were highest in the summer, 2. the highest total-P concentrations were shared by two of the seasons in any single year, 3. the soluble-P values were similar for all seasons and 4. the chloride levels were always highest in the spring. The mean event flows were highest in the spring for all stations in any single year. The large size and multiple land uses characterizing each tributary area normalized the mean event parameter concentrations between some of the stations during a season. For example, total- and soluble-P concentrations were similar at all stations during a season except at stations 413009 and 683002 which had concentration values affected by sewage treatment plant discharges. The mean seasonal event suspended solids concentrations at stations in the lower more urbanized part of the Menomonee River Watershed were always higher than concentrations at stations in the less urbanized upper watershed. Mean seasonal concentration of pollutants associated with particulate matter were usually higher during runoff events than during baseflow; soluble parameter levels were usually similar or lower during events than during baseflow. The importance of non-point source contributions to the level of particulate parameter in the river system is demonstrated clearly by the relatively high mean concentration of suspended solids, total-P and lead for events. Mean seasonal event concentrations of suspended solids were lower in the inner harbor than in the river; total- and soluble-P concentrations were similar in the two systems.

Bacterial counts were usually higher during events than baseflow. Bacterial counts during events were usually lower at stations with predominantly rural tributary areas.

Comparison of overall mean parameter concentrations with water quality criteria indicate that the levels of lead, suspended solids, total-P and fecal coliforms exceeded the acceptable levels for drinking water and/or freshwater aquatic life.

A significant linear correlation was observed between suspended solids and total-P concentrations at all stations during each season. The significant correlation between suspended solids and total-P suggests that a management strategy to control suspended solids also will reduce the input of the pollutants associated with particulate matter. Metals--exemplified by lead--are included in the group of parameters likely to be controlled by management of suspended solids sources. In most cases, a positive linear correlation was evident between flow and suspended solids but only occasional significant correlation was observed for total-P and soluble parameters with flow.

The levels of suspended solids, total-P and lead always increased in the rising stage of an event hydrograph as the overland flows produced washoff of particulates. Soluble-P levels usually did not increase during events. The variability in the concentration values for these parameters reveals that a runoff event can only be characterized fully by sampling across the entire hydrograph. The significant correlation observed between loading rates of all the key parameters and flow during events suggest that flow is more important to the determination of loading rate than concentration. The relationship of concentration of the key parameters to flow and loading rate were less predictable.

Seasonal event unit loadings varied between seasons for each station and between stations during a season. The significant correlation observed between seasonal parameter loadings and runoff (water loading) suggests that the differences between seasons is largely accounted for by variation in the amount of runoff. Changes in concentrations would account for any variability in the relationship. Although the parameter and water unit event loading values could be grouped into several ranges for each season, the most urbanized station (413006) was usually amongst the group with the highest unit loadings of water, suspended solids, total-P and lead and the least urbanized station (673001) was usually amongst the group with the lowest loadings for these parameters. The seasonal event loadings usually were a significant portion of the total seasonal loadings (event plus baseflow); event contributions accounted for a greater proportion of the total annual loadings of suspended solids and total-P than point sources. Considerable amounts of the event loadings in the Watershed for 1976 and 1977 were contributed by three and two big events, respectively.

In order to develop non-point source remedial measures for the mainstem river stations, it is important to identify factors responsible for accelerating the pollutant loadings in the tributary areas. The factors affecting loading are hydraulic factors which determine the amount of runoff and the land use activities that affect pollutant concentrations. The hydraulic factor most manageable and important in urban areas is the degree of connected imperviousness area in a tributary area. Water, suspended solids and total-P seasonal unit event loadings were significantly correlated to degree of conrected imperviouness area in 1977. The storm sewered station with the highest degree of connected imperviousness (413006) usually generated the highest amount of runoff and unit loading values of suspended solids. The station with natural drainage and the lowest percent connected imperviousness (673001) usually generated the lowest amount of runoff and suspended solids loadings. Variability in the relationship between loading and connected imperviousness was due to other hydraulic factors affecting the large amounts of pervious area in each tributary area. Temporary land use activities such as construction and road salting and long term activities such as heavy vehicular traffic and industrialization affect the amount of pollutant material available for transport. Although the most critical land use/land activities could not be isolated from the mixed land uses present in the tributary areas, the stations with more urbanized land uses usually had higher loadings of suspended solids and lead. Remedial measures should be based on controlling land use activities which result in high pollutant concentrations and towards those areas, which because of their hydraulic characteristics like high degree of connected impervious area, generate persistently high pollutant loadings.

Analysis of rainfall-runoff relationships indicates that runoff was not significantly correlated with rainfall except at the station (413006) with a high degree of connected impervious area. The percent of runoff did not necessarily increase in seasons with large amounts of rainfall. The impact of the amount of rainfall on this percentage of runoff is modified by the effect of factors such as evapotransporation.

The occurrence of first flush during events was observed but was not consistent.

I-3. MATERIALS AND PROCEDURES

Site Selection

Selection of the mainstem river monitoring sites was guided primarily by distribution of land uses in the Menomonee River Watershed and the location of tributary/mainstem confluences. Sites were also selected to characterize water quality in the inner Milwaukee Harbor. Land use in the Watershed can best be delineated as an industrial-commercial complex in the lower quarter, a low to medium density residential section in the center half and an area of transition from rural to urban land use in the upper quarter. Land use distribution monitored at each of the automatic sampling sites is shown in Table I-1. Principal river tributary sites were established to divide the total Watershed into more manageable proportions and to allow direct loading comparisons between these subwatersheds and the Watershed as a whole. Further comparisons were obtained between the mixed land use areas tributary to the mainstem stations and the drainage from the predominantly single land use sites (1). To calculate land use distribution directly adjacent to a sampling site it is necessary to examine the footnotes to Table I-1. Other land use information can be found (2).

In total, nine automatic sampling stations were established on the mainstem and principal tributaries of the Menomonee River and three grab-sampling sites (413014, 413013, 413012) were located in the inner Milwaukee Harbor area. The sites were numbered according to the format used for the U.S. EPA STORET data base (Fig. I-1).

Principal criteria used to locate a sampling site were: 1. Availability of a suitable construction area close enough to the stream, 2. suitability of the stream channel for accurate measurement of flow and representative sampling for water quality and 3. ease of accessibility. Permission (private and governmental) to construct the stations at the chosen sites was obtained between June and October 1974.

The grab sampling stations in the inner Harbor area were located at bridges.

Sampling Equipment

Sampling equipment was housed in stone, brick or aluminum shelters of approximately 3 x 3 m dimensions. The stations were constructed by the U.S. Geological Survey (USGS) and an example of a shelter is shown in Fig. I-2 and the flow and water sampling equipment in Fig. I-3. Each shelter was

Table I-1. Land use categories (1975) in areas tributary to the main stem monitoring stations

STORET number	Land use* distribution, ha															Imperviousness, %	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Total†	Connected††
673001	57 (1.2)**	97 (2.0)	23 (0.5)	32 (0.7)	269 (5.6)	71 (1.5)	94 (2.0)	1,621 (34)	1,566 (33)	626 (13)	281 (5.9)	14 (0.3)	0	22 (0.5)	4,774	5	1
683002***	92 (1.0)	178 (0.2)	105 (1.2)	54 (0.6)	1,016 (12)	123 (1.4)	249 (2.8)	2,484 (28)	2,835 (32)	994 (11)	611 (6.9)	17 (0.2)	1 (0.0)	38 (0.4)	8,797	8	2
683001+	239 (1.6)	517 (3.3)	248 (1.6)	74 (0.5)	2,938 (19)	181 (1.2)	599 (3.9)	3,422 (22)	5,020 (32)	1,325 (8.6)	775 (5.0)	20 (0.1)	23 (0.1)	69 (0.4)	15,450	12	3
413008	52 (1.0)	277 (5.4)	55 (1.1)	101 (2.0)	765 (15)	58 (1.1)	201 (3.9)	1,329 (26)	1,701 (33)	413 (8)	148 (2.9)	13 (0.2)	28 (0.5)	23 (0.4)	5,163	14	6
413007	118 (2.4)	437 (8.8)	116 (2.3)	84 (1.7)	2,288 (46)	8 (0.2)	171 (3.4)	29 (0.6)	1,340 (27)	193 (3.9)	138 (2.8)	0	40 (0.8)	12 (0.2)	4,974	28	7
413006	41 (1.5)	220 (7.8)	62 (2.2)	166 (5.9)	1,642 (59)	0	64 (2.3)	15 (0.5)	554 (20)	14 (0.5)	9 (0.3)	0	13 (0.5)	4 (0.1)	2,803	45	28
413005++	638 (2.0)	2,104 (6.5)	542 (1.7)	604 (1.9)	9,110 (28)	247 (0.8)	1,073 (3.3)	4,806 (15)	9,762 (30)	1,969 (6.1)	1,069 (3.3)	32 (0.1)	106 (0.3)	142 (0.4)	32,205	22	9
413009	0	13 (7.2)	0	6 (3.3)	139 (77)	0	0	0	23 (13)	0	0	0	0	0	182	56	34
413004+++	882 (2.6)	2,519 (7.3)	609 (1.8)	667 (1.9)	10,130 (29)	248 (0.7)	1,081 (3.1)	4,806 (14)	10,108 (29)	1,969 (5.7)	1,069 (3.1)	32 (0.1)	120 (0.3)	157 (0.4)	34,397	24	11

*Land use categories are: 1-industrial, 2 commercial, 3-freeway (other roads are proportionately distributed among the other land uses), 4-high density residential, 5-medium density residential, 6-low density residential, 7-land under development, 8-row crops, 9-pasture and small grains, 10-forested land and woodlots, 11-wetlands, 12-feedlots, 13-landfill and dumps, 14-water areas (land use categories are described in Table III-5 found in (2).

**( ) percent distribution.

***To obtain area adjacent to station subtract values for 673001 from values for 683002.

+To obtain area adjacent to station subtract values for 683002 from values for 683001.

++To obtain area adjacent to station subtract values for 683001, 413007, 413006 and 413008 from values for 413005.

+++To obtain area adjacent to station subtract values for 413005 from values for 413004.

†Total imperviousness of area adjacent to stations 683002, 683001, 413005 and 413004 are 12, 16, 47 and 65%, respectively.

††Connected imperviousness of area adjacent to stations 683002, 683001, 413005 and 413004 are 3, 3, 27 and 46%, respectively.

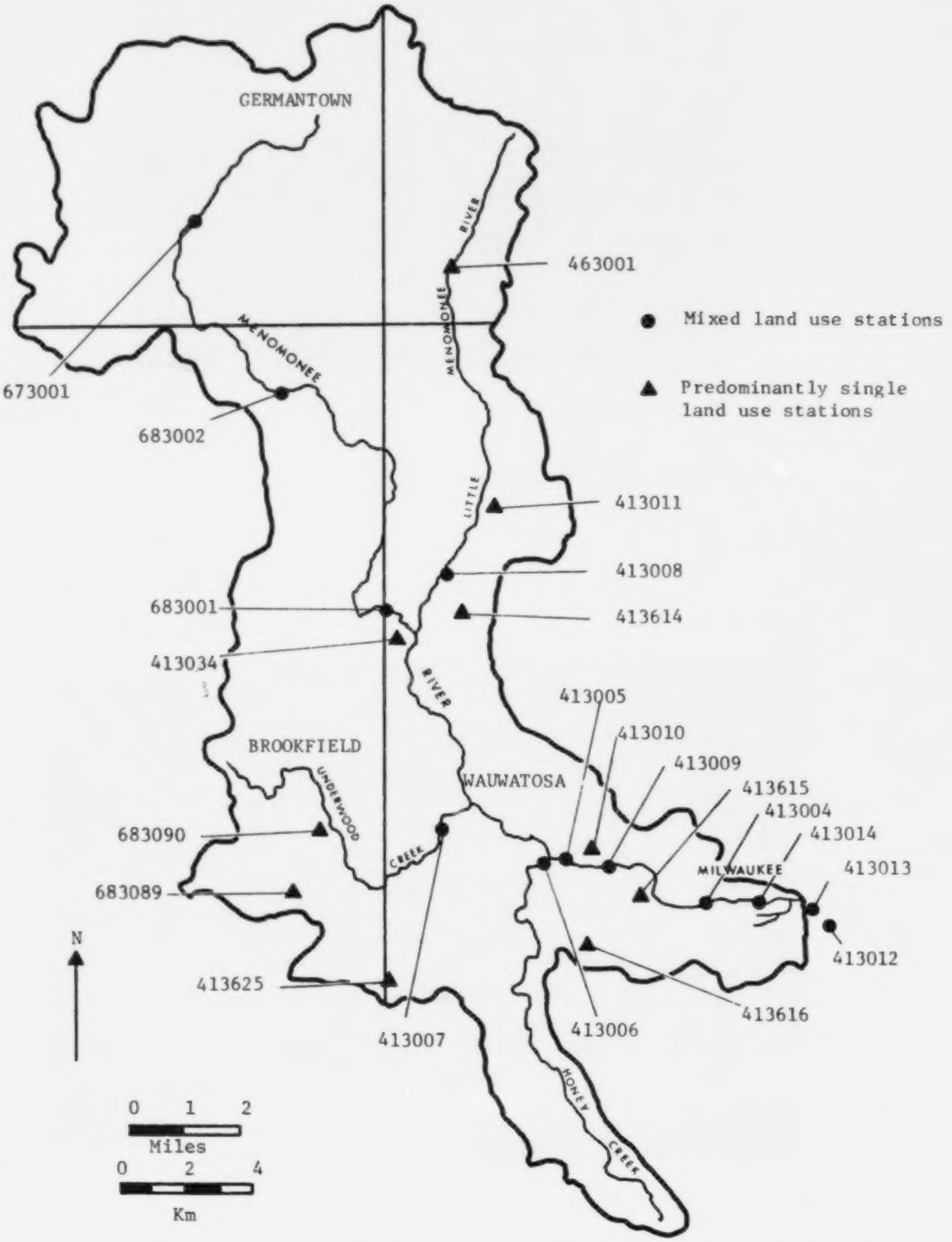
GERMANTOWN
MENOMONEE RIVER
463001
● Mixed land use stations
▲ Predominantly single land use stations
673001
MENOMONEE
683002
LITTLE
413011
413008
683001
413614
413034
RIVER
413005
413010
413009
BROOKFIELD
UNDERWOOD
WAUWATOSA
413615
413004
413014
683090
CREEK
MILWAUKEE
413013
683089
413012
N
413625
413616
413007
413006
HONEY
CREEK
0 1 2
Miles
0 2 4
Km

Fig. I-1. Locations of monitoring stations within the Menomonee River Watershed.

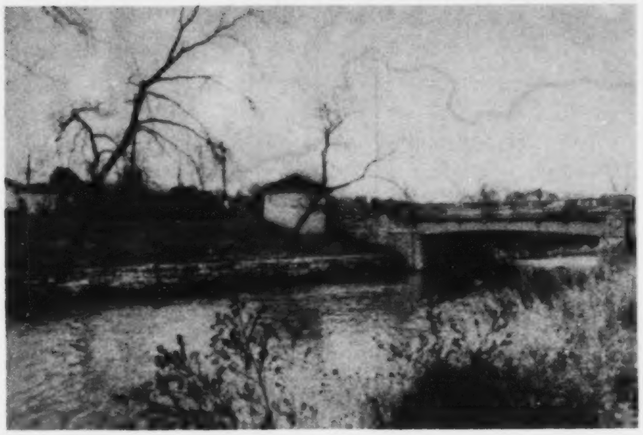

Fig. 2. Station house.

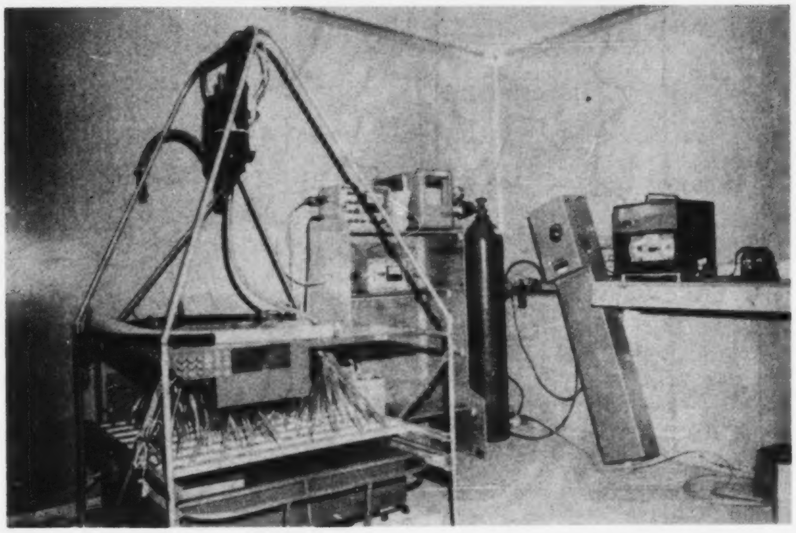

Fig. 3. Sampling equipment.

heated in winter and furnished with electrical power.

The USGS-designed PS-69 water sampler--manufactured by the St. Anthony Falls Hydraulics Laboratory--was installed at each location. Power was provided either from 3 x 12 volt automobile batteries, wired in series, or from the DC output of a transformer. An impeller pump served to draw water samples through a 2-cm plastic and copper intake line positioned 15 cm above the river bed. Height of the intake corresponded to average water depth during summer baseflow periods. The inlet--positioned perpendicular to the direction of flow--was placed in the center one-third of the stream. If the intake line on the sampler was clogged, a blown fuse curtailed further sampling. At some stations clogging of the inlet with filamentous algae or other debris was fairly frequent in the early stages but the problem was later alleviated by angling the intake pipe at about 45°. A rotating arm on the sampler distributed the water to 72 wide-mouthed, 1-L polypropylene bottles.

Stage height of the stream was measured using manometers manufactured by Scientific Instruments and recorded on a digital tape recorder (Fisher Porter); samples were collected at hourly intervals and marked on the tape recorder. Stations 413005, 413006, 413007 and 683001 utilized a Stevens Recorder that traced the shape and size of the hydrograph on a stage chart. Dissolved oxygen and temperature were measured during baseflow with a Yellow Springs Instrument Co. dissolved oxygen meter.

Five of the mainstem monitoring sites (673001, 683001, 413008, 413005 and 413004) were equipped with Hydrolab continuous monitoring meters which recorded pH, conductivity, dissolved oxygen and temperature. The equipment consisted of electrodes housed in a protective plastic casing, a data scanner capable of separating data impulses and a strip chart recorder. The system was powered by a 12-volt automobile battery and internal mercury batteries. Depending on conditions the probes were calibrated once or twice a week. The strip charts were digitized and stored on computer magnetic tapes for further analysis.

Grab samples at the inner harbor stations were obtained with 1-L Kemmerer bottles.

Sampling Procedures

The objectives of the project dictated that emphasis on sampling be placed on runoff events since baseflow loadings comprise only a small fraction of the total tributary loadings to Lake Michigan. During the course of runoff event sampling, collections were made to delineate the entire hydrograph and its corresponding pollutograph.

Initiation of sampling occurred at station 413005 in June 1975, stations 683001, 413006 and 413009 were completed for sampling in spring 1976, and the remainder were ready for sample collection in spring 1977. Sampling dates and parameters measured are shown in Tables I-2 and I-3 for 1976 and

Table I-2. Dates and parameters for runoff events sampled during 1976 at main stem river stations

	Parameter measured at station:			
Date, 1976	683001	413006	413005	413009
4-24	---	N,M(5.3)	N,M(4.5)	---
5-5	N*(3.2)**	---	N(2.3)	---
5-15	---	N(2.2)	N(2.7)	---
5-28	N(1.0)	N(0.4)	N(1.1)	---
6-14	N,M(2.9)	N,M(1.9)	---	---
6-18	---	---	N(0.90)	---
7-28	N(1.0)	N(0.9)	N,B,O(0.9)	---
7-30	N(0.8)	---	N(3.2)	---
8-5	---	N(0.07)	N(0.4)	---
8-25	---	N(0.5)	---	N(0.6)
8-28	N(2.3)	N(2.3)	N(2.2)	N(2.2)
9-1	---	N(0.3)	---	N(1.0)
9-9	---	---	N(1.7)	---
9-19	N(0.6)	---	N(1.0)	---
10-5	---	---	N(3.3)	---
10-24	---	N(0.4)	N(0.4)	---
10-26	---	N(0.4)	N(0.3)	---

*The letter N(nutrients), M(metals), B (bacteriological), and O (organic) represent parameters from Group A, Group C (inorganic), Group B and Group C (organic), respectively, of the PLUARG core list.

**Average rainfall (cm) for area tributary to station.

---No sample.

Table I-3. Dates and parameters for runoff events samples during 1977 at main stem river stations

Date, 1977	Parameters measured at station:								
	673001	683002	683001	413008	413007	413006	413005	413009	413004
3/3-5	N*(1.68)**	N(1.57)	N(1.58)	N(1.50)	N(1.80)	N(1.72)	N(1.70)	N(1.70)	N(1.70)
3/12			N(0.84)			N(0.80)	N(0.82)		
3/18-20			N(0.88)				N(0.12)		
3/27-30	N(0.96)	N(4.47)	N(3.33)	N(4.59)	N(3.86)	N(1.70)	N(4.40)		N,M(4.40)
4/1-3	N(1.70	N(1.58)	N,(2.18)	N(2.12)	N(2.06)		N(1.85)		N(1.85)
4/20-21			N(1.06)	N(1.14)	M(1.17)	N(0.95)	N(1.00)	N(1.12)	N(1.00)
4/24-25						N(0.25)			
4/27-28						N(0.10)			
5/5					N(0.46)				
5/31						N(0.25)		N	
6/5-6	N,M(2.54)	N,M(3.50)	N,M(3.62)		N,M(3.50)	N,M(4.06)	N,M(3.75)		N,M(3.75)
6/8-9	N(0.03)		N(0.58)		N(0.71)	N(0.51)	N(0.66)		N(0.66)
6/11-13		N(5.07)	N(4.52)		N(1.96)	N(1.50)	N(3.32)		N(3.32)
6/28					N,B(1.50)	N,B(2.21)	N,B(1.09)	N,B(1.50)	
6/30			N,M(0.86)			N,M(2.25)	N,M(1.33)		
7/6-7			N(0.59)		N(0.89)	N(0.46)	N(0.59)		
7/17			N(2.23)		N(5.79)	N(4.76)	N(3.23)		N(3.23)
7/18-19	N,M,B(5.26)	N,M,B(4.19)	N,M,B(3.94)	N,B(3.34)	N,M,B(3.15)	N,M,B(4.48)	N,M,B(3.82)		N,M,B(3.82)
7/20-21		N(2.41)	N(1.72)			N(0.56)	N,M(1.26)		N(1.26)
8/2-6	N,M(5.41)	N(3.98)	N(3.22)	N(2.25)	N(2.22)	N(2.46)	N(2.84)	N(2.54)	N(2.84)
8/8-9		N(1.08)				N(1.28)	N(1.28)		N(1.28)
8/13		N(3.26)	N,M(3.65)	N(3.26)	N(1.68)	N(2.27)	N(2.82)	N(2.44)	N(2.82)
8/16						B(0.62)			
8/28				N,M(4.18)		N,M(3.07)	N,M(3.86)	N,M(3.33)	N,M(3.86)
9/1-2							N(0.53)		
9/4							N(0.46)		
9/12						N,B(1.14)	N,B(1.36)		
9/17-18							N(1.43)		
9/23-24							N,M(2.34)		
10/7							N		
12/17						N,M	N,M		

*The letters N (nutrients), M (metals), B (bacteriological, O (organics) represent parameters from Group A, Group C (inorganic) and Group B, respectively, of the PLUARG core list.
**Average rainfall (cm) for area tributary to station.

1977, respectively. For comparative purposes, event samples were collected at predominantly single land use sites in 1976 and 1977 (1).

During the course of an event, samples (700 ml) were collected at hourly intervals until the stage dropped below the original triggering height or the sampler was manually turned off. Samples were removed during or as quickly as possible after the event terminated. Depending on the size of the event, five or more samples were selected for analysis; larger sample numbers were selected during the period of spring runoff. Selection was based on observation of the field-drawn hydrographs and samples were chosen on the rising, peak and falling stages of the hydrographs. Actual time of sampling was recorded on digital tape.

For transport to the laboratory for analysis, the samples were placed in narrow-mouthed polypropylene bottles and mailed immediately or stored in a frozen condition (Wisconsin Department of Natural Resources Southeastern Office). All samples were mailed in styrofoam containers (4 samples each) fitted with an ice compartment. The wide-mouthed bottles used in the automatic samplers were replaced after washing in phosphorus-free detergent and rinsing with distilled water.

Periodic sampling during non-event stages were conducted at each mainstem location. In 1975, sampling was scheduled 1. at 2-week intervals during January through March; 2. twice a week in April through June; and 3. once a week July through December. In 1976 baseflow was surveyed on a weekly basis from January through March and every two weeks between April and December. All baseflow samples collected in 1977 were obtained on a monthly schedule. Confusion sometimes occurred between event and non-event surveys during periods of high spring runoff. Transportation and storage of non-event samples corresponded to the procedures described for event sampling. Furthermore, two grab samples were collected at one station (chosen randomly) during each non-event sampling collection. The grab samples were obtained very close to the inlet of the samplers. These samples provided some quality control information on such factors as sample storage effects, river homogeneity and differences between sampling methods. For comparison with event samples, *in situ* measurements of dissolved oxygen, conductivity and temperature were obtained during each survey.

Grab samples in the inner harbor area were collected during and between runoff events. The days chosen for this sampling usually were not determined by flow conditions and consequently the majority of samples were obtained between events. In 1975, the harbor sites were surveyed every 2 weeks from January through March and July through December and each week from April through June. In 1976, the survey was conducted every 2 weeks while an irregular schedule was maintained in 1977; spring and summer sampling in 1977 occurred at approximately monthly intervals. Samples were obtained with a 1-L Kemmerer bottle lowered from a bridge. The water was sampled at the surface, at approximately mid-depth and at about 1.5 m from the bottom; dissolved oxygen, conductivity and temperature were determined by *in situ* methods at each depth. All samples were transported and stored by the procedures described earlier.

Effluent samples were collected for water quality analysis at the

Germantown Waste Treatment Facility on September 18, 1975 and July 13, 1976 and at the Parkside and Parkview Facilities of the City of Menomonee Falls on June 19 and 25, 1975 and on September 1, 1976. At each survey, 24-hr composite samples were collected and analyzed.

Laboratory Analysis

A listing of the water quality parameters determined on Menomonee River samples is shown in Table I-4. With the exception of hardness, alkalinity and total organic carbon, all group A parameters were determined on most of the event and non-event samples. The other groups of parameters were analyzed less frequently. For the bacterial parameters (group B), analysis was conducted on small grab samples. When pesticides (group D) were scheduled for determination, large grab samples were collected and stored in glass bottles. Group C parameters were determined on the automatically-collected samples but were transported and stored in bottles separate from the group A samples.

All analyses were conducted at the Wisconsin State Hygiene Laboratory located at the University of Wisconsin-Madison some 130 km from the sampling sites. Those parameters likely to undergo rapid transformation (e.g., inorganic nitrogenous forms) were analyzed within 24 hr after arrival at the Hygiene Laboratory. To prevent overloading of the analytical capability, some samples were held in a frozen condition in Milwaukee until it was convenient to receive them in Madison.

Analytical procedures used for the analysis of nitrogen and phosphorus forms, total organic carbon, metals and phenols were those recommended by the U.S. EPA (3). Nitrogen and phosphorus forms were determined by approved autoanalyzer techniques (3). Digestion of samples for metal analysis was described in (3) and atomic absorption spectroscopy utilizing a graphite furnace was--in most cases--the chosen method of determination. Flame atomic absorption spectroscopy was used for determination of magnesium, zinc and iron. Alkalinity hardness, total-, suspended- and volatile suspended-solids; chloride; and the group B parameters were analyzed by methods described in (4). Group D parameters, except phenols, were analyzed by methods contained in the Federal Register (5).

The data were filed in the STORET data base and in the WDNR computer mass storage files for reporting and statistical analysis.

Methods for Calculating Loadings

The term "hazardous land use" is relative, being defined as a land use from which significantly greater amounts of a pollutant are derived. It is possible to calculate pollutant from land use activities in a number of ways; however, it must be kept in mind that the goal is to be able to

Table I-4. Water quality parameters

Parameter group			
A	B	C	D
Organic N	Total coliform counts	Copper	PCBs
Ammonia-N	Fecal coliform counts	Lead	DDT
Nitrate + nitrite-N	Fecal streptococci counts	Zinc	DDD
Total P		Chromium	DDE
Dissolved reactive P*		Arsenic	Heptachlor
Alkalinity		Selenium	Aldrin
Hardness		Nickel	Lindane
Chloride		Cadmium	Heptachlor epoxide
Total organic C		Iron	Dieldrin
Suspended solids		Manganese	Methoxychlor
Volatile suspended solids		Aluminum	Phenols
Total solids		Dissolved reactive silica	

*Also filtered reactive P and is referred to as soluble P in the text or elsewhere.

statistically compare loading values. Consequently, the method of calculating loads should 1. be consistent with the assumptions associated with the sampling schemes that were used, and 2. be capable of estimating the variance associated with each load (to permit a statistical comparison).

Initially, loads for the Menomonee River Watershed were calculated using an "integration" method whereby loading values were possible only for events for which concentration data were available. This "model" linearly interpolated between measured concentration data points in order to assign a concentration for each measured instantaneous flow. For events during which extensive concentration information is available, this interpolation routine can be a reasonable approximation of concentration variation with time. For events with limited concentration information, the interpolation routine can introduce unsystematic (and unquantifiable) variation. The integration method does not produce loads for events for which flow information is available, but concentration information is not; and it does not produce any estimate of the variation associated with the loads it produces.

A stratified random sampling model enhanced by a ratio estimator has been described for pollutant loading calculations at the monitoring stations (6). The assumptions of the model are: 1. Simple random sampling of water quality within nonoverlapping subpopulations or strata is possible and 2. supplemental flow information is available rather than instantaneous flow values taken only at those times when water quality samples were taken. This model meets the goal stated above in that it produces load and variance estimates for each stratum and for the sum of the strata.

The technique of stratifying subsample data is used because it provides a means of gaining precision in estimates by clustering homogeneous units (periods of like concentrations). The overriding assumption of this technique is that a better estimate of what is occurring in the population can be gained by observing subpopulation characteristics rather than by sampling from the population as a whole. The procedure for the stratified random sampling model consists of the following stages: 1. Division of a heterogeneous population into strata, each of which is internally homogeneous (to the extent that each stratum is homogeneous, a precise estimate of the pollutant load can be made); 2. the selection of a random sample from each stratum; and 3. the consolidation of the strata statistics into a combined statistic weighted for size of strata.

Since water quality samples were gathered without regard for strata, the selection of strata in the application of this model is particularly critical. Two general criteria must be met in this selection: 1. Subsamples within a stratum must have had equal probability of being chosen (subsamples gathered under different collection frequencies must not be in the same stratum); and 2. homogeneous units can be determined after examination of the subsample data, but must not be tailored to each data point (i.e., a generally applicable set of rules for inclusion in a stratum should be developed).

The process used to apply the stratified random sampling model to water quality data collected in 1976 as part of the Menomonee River project is described. This example serves to acquaint interested researchers with an acceptable method to calculate pollutant loads.

At all stations, water quality samples were collected systematically during all event times during which automatic samplers were functioning. At those stations which had flow during non-event periods, samples were collected for those periods on an irregular schedule. Continuous flow monitoring data were collected for all stations for the year. Concurrently, continuous rainfall monitoring data were collected at sites throughout the Watershed.

First, determine if the assumption of random sampling within a stratum dictates that certain data should not be grouped together. For the Menomonee River stations where water quality was systematically sampled during events and irregularly during non-events, two strata were dictated by the assumptions of the model. Other sampling situations that could result in data not being grouped within a stratum include changing the sampling frequency on an automatic sampler, or changing the schedule for the collection of non-event samples.

For the Menomonee River project, estimated loadings were compared on an annual basis, between seasons at a station, and within a season at all stations. As a result, seasonal loads were estimated. While the initial reason for this move was to be able to compare estimated loadings for seasons, the resulting partition separated the water quality concentration data points on the basis of storm type, stage of vegetation and other seasonal factors which may or may not be related to observed concentrations. At stations for which non-event water quality was sampled, eight strata were defined for 1976, i.e., event and non-event data for each of four seasons. For stations at which only event water quality was sampled, four strata were defined.

Having satisfied the key assumptions of the model, any additional strata are designated for the purpose of calculating a more precise estimate of load (i.e., for minimizing the variance associated with a load estimate). To accomplish this, similar concentrations are grouped within the same stratum after previewing the concentration data plotted against time, instantaneous flow, rainfall intensity, or any other factor related to concentration.

In an attempt to reduce the variance associated with the estimated seasonal loading (and the estimated annual loading), the concentration data were previewed for each season at each station. Concentration changes with time and concentration against instantaneous flow were plotted in order to gain insight into the factor(s) accounting for observed variability in the concentration data. Observing concentration variations with time permits the examination of hydrograph positional effects, i.e., concentration variations between ascending and descending portions of the hydrograph (e.g., the first flush effect). Viewing plots of concentration versus instantaneous flow permits the examination of a correlation between flow and concentration; higher concentrations occurring primarily with higher flow, or, conversely, higher concentrations occurring primarily with lower flows.

If the ascending compared with the descending limb of the hydrograph was adopted as a rule for further stratification for one or more seasons, all times during which events were identified would have to be assigned to either the ascending stratum or the descending stratum. A complication arose in this regard. During events with multiple peaks, observed concentrations fluctuated in an apparently unsystematic fashion. Occasionally each of the multiple peaks evidenced a first flush. In other instances only one peak displayed this effect. This inconsistency makes assigning all time during the season a difficult, if not unsupportable, proposal. In addition, a comparison of stratification on the basis of ascending versus descending limb (for one event for which extensive concentration data were available) to stratification on the basis of flow showed no difference in either the estimated load or the variance associated with the estimate. For these reasons, stratification on the basis of a flow rule was chosen over stratification on ascending versus descending limb of the hydrograph.

Underlying stratification on the basis of flow is the assumption that relatively similar concentrations are observed with similar flows. Central to this process is the determination of the flow cutoff rule. For the Menomonee project, two general types of flow cutoff rules were investigated: 1. For each event hydrograph a flow cutoff is chosen, and 2. for each season a flow cutoff is chosen. An event based cutoff rule groups concentrations across events on the basis of the instantaneous flow when the water quality sample was collected. This implies that concentrations observed during event times when flow is higher than the cutoff would be expected to be similar not only within each event, but also across events. Setting a flow cutoff for events during which water quality samples were collected is obviously more straightforward than setting a cutoff for events during which no samples were collected. Again, a general rule must be established in order to accomplish this task (e.g., a cutoff flow of 1. 0.5 (event peak flow), 2. 0.5 (event initial flow and event peak flow), or 3. [peak flow-(event peak flow-event initial flow)]. A seasonal flow cutoff rule also groups concentrations on the basis of the instantaneous flow when the water quality sample was collected; however, there is one cutoff flow which determines the assignment of concentration data points to strata for an entire season.

Visual inspection of the plots of concentration against flow for a season and concentration with time for a season did not provide information by which either of the two general types of flow cutoffs could be chosen. Load estimates calculated using different specific rules for each of the general flow cutoff types were compared for a series of events for which extensive concentration data were available. There was no trend in the variance estimates which favored one general type of flow cutoff rule over the other.

The next consideration in choosing the general type of flow cutoff is the ease of application of the method. For the event based cutoff rule for events during which many water quality samples were collected across the hydrograph, choosing a reasonable cutoff flow is straightforward. With few water quality samples for an event or with a poor distribution of water quality samples across the hydrograph, the choice of a cutoff flow becomes difficult. However, in order to arrive at a general rule to apply to event times for which flow information is available but water quality data is not, enough event hydrographs must be examined for each season to be able to characterize what is being observed in terms of flow versus concentration for an event. To the extent that this characterization of events is possible, a reasonable general rule can be determined. If a good characterization is not possible, then it is not possible to determine a general rule for stratification. For the seasonal cutoff flow rule, the assumption is that higher concentrations are associated with similar flows (high or low) for the season under consideration. From an additional examination of the plot of concentration versus instantaneous flow, good candidates for the seasonal cutoff flow can be determined. For the Menomonee River Project the seasonal cutoff flow approach was chosen over the event based cutoff flow for two reasons: 1. The two methods were indistinguishable on the basis of estimated load or variance for test data, and 2. the application of the seasonal cutoff flow approach is more straightforward.

For the purposes of further illustrating the process of choosing a cutoff flow for stratification, Figs. I-4 and I-5 are included. Each figure includes a plot of suspended solids concentration versus the instantaneous flow at the time when the water quality sample was collected, and a plot of instantaneous discharge and suspended solids concentration with time. All plots are for the time period March 26, 1976 to June 1, 1976. No single cutoff flow is obvious.

To investigate the effect of different cutoff flows on the estimated load and its associated variance, loads were calculated using several stratification schemes. A one stratum scheme was used as a baseline. Four different two strata schemes were used for each of the two stations represented by Figs. I-4 and I-5. Flow cutoffs were chosen to represent an approximate range of 5 to 30% of the peak flow for the season. For the stations and season represented by Figs. I-4 and I-5, estimated loads and variances (actually the square root of the mean squared error, which is an estimate of the standard deviation) in kg/ha of suspended solids for the stratification schemes are shown in Table I-5.

While the size of the variance term is the sole criterion with which to judge which of several estimated loadings is the most precise, an additional factor must be taken into account before a final choice is made. The additional factor that must be considered is the degrees of freedom (df) associated with an estimated load, which is important in statistical comparisons. Generally, with more df, a more sensitive comparison can be made. However, the rate of increase in sensitivity with more df from 1 to 15 df is much greater than from 15 to 120 df. Consequently, if estimates having greater than 15 df are compared, it is generally safe to choose on the basis of the smallest associated variance. If, on the other hand, the estimates have < 15 df associated variances that vary and a Student's t--distribution table should be referenced in order to assess the increase in sensitivity traded for a greater variance.

For the estimated loadings and variances located above, all df were

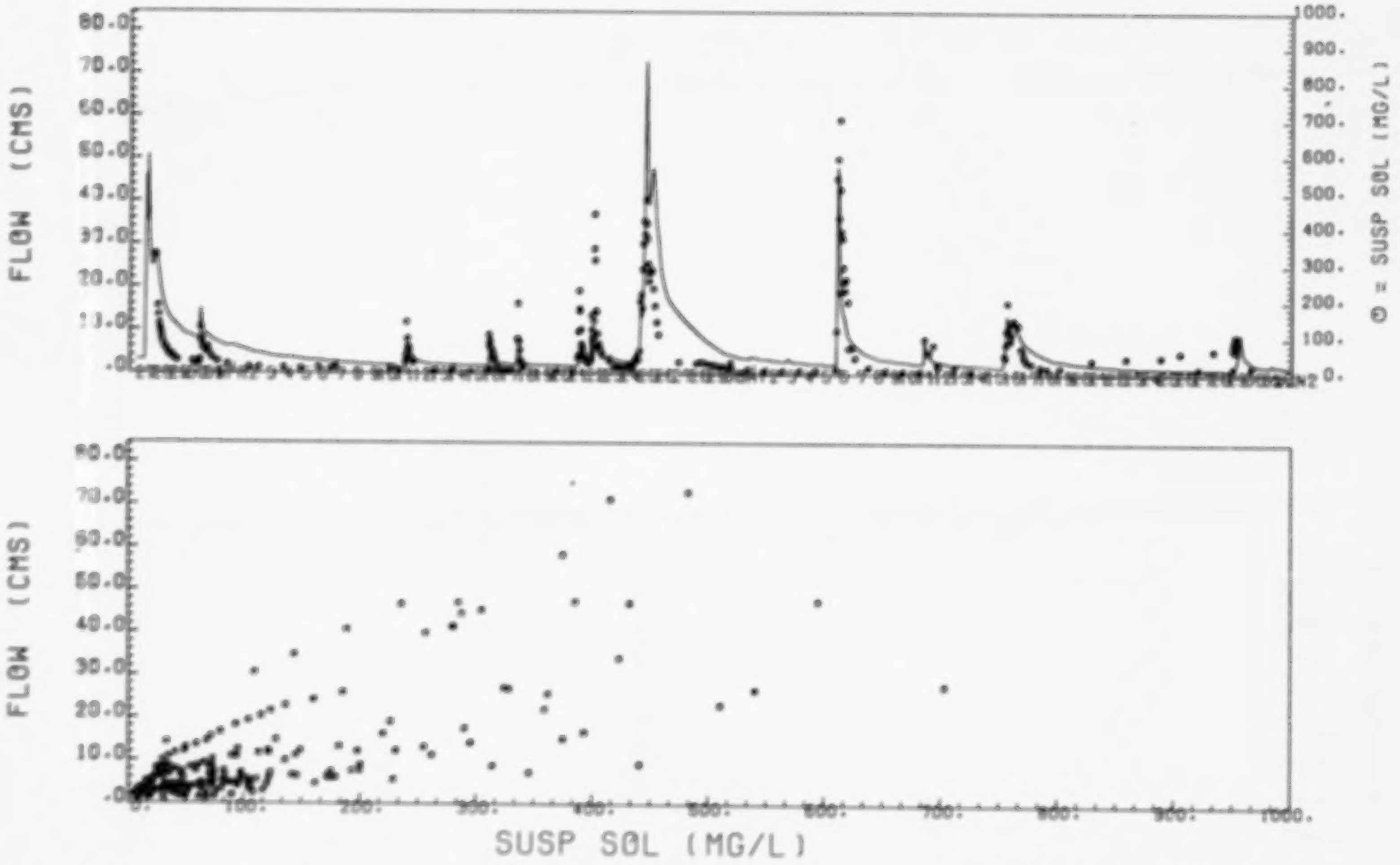

Fig. I-4. Flow and concentration of suspended solids against time (upper curve) and flow against concentration of suspended solids (lower curve) at 70th St. (413005) for the time period March 26 to June 1, 1976.

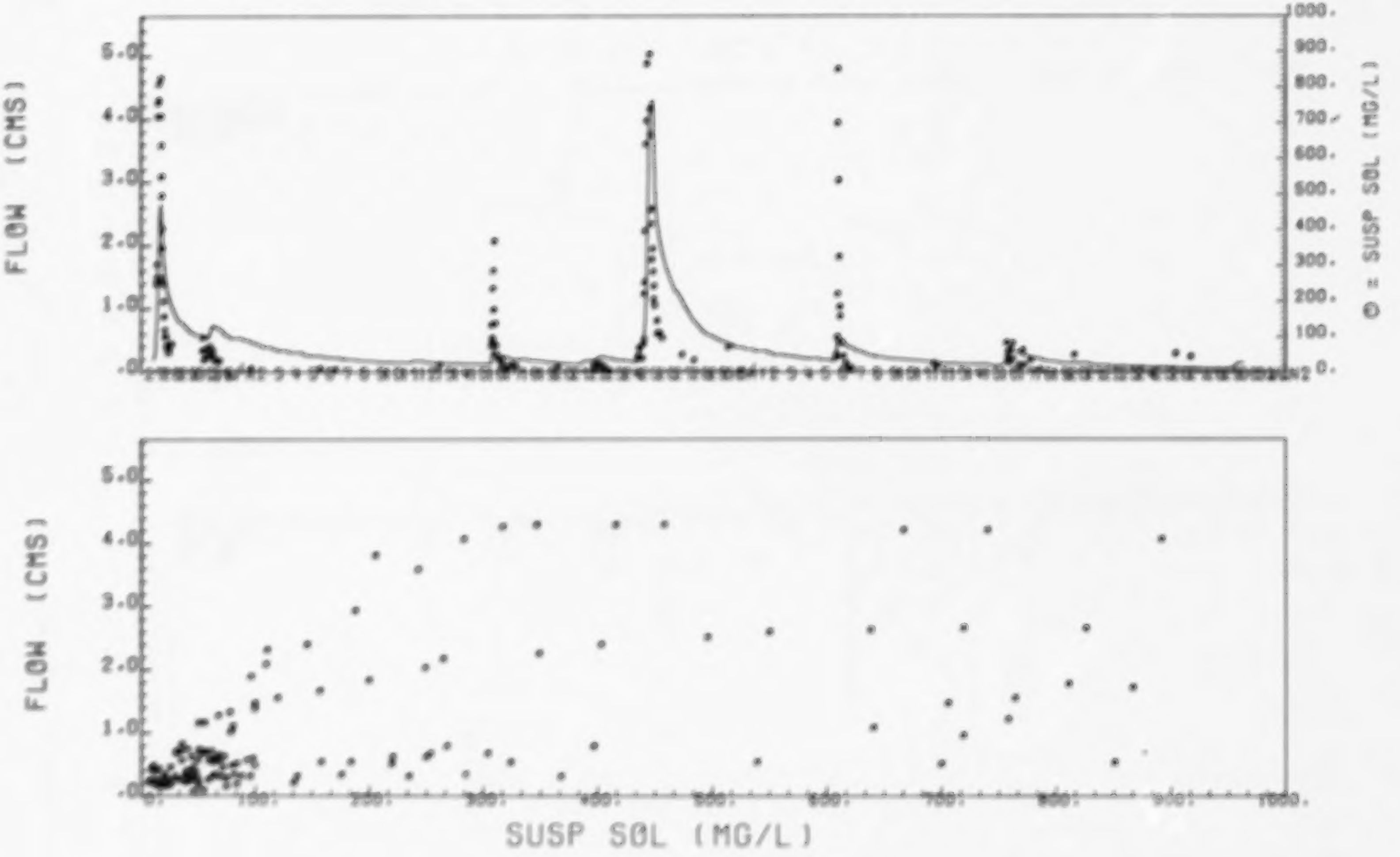

Fig. 1-5. Flow and concentration of suspended solids against time (upper curve) and flow against concentration of suspended solids (lower curve) at Donges Bay Rd. (463001) for the time period March 26 to June 1, 1976.

Table I-5. Loading estimates for different stratification schemes

Stratification scheme	Flow cutoff, cms	Load estimate, kg/ha	Standard deviation, kg/ha
		From Fig. I-4	
One stratum	--	133	12.9
Two strata	28	121	9.2
Two strata	8.5	128	11.1
Two strata	5.7	132	12.3
Two strata	3.5	134	13.1
		From Fig. I-5	
One stratum	--	196	34.9
Two strata	1.4	150	15.3
Two strata	0.57	181	25.4
Two strata	0.42	177	23.0
Two strata	0.20	189	27.0

< 50. This would lead to deciding on cutoff flow on the basis of the size of variance, and the eventual choice of two strata for each season with cutoff flows of 28 cms for Fig. I-4 and 1.4 cms for Fig. I-5.

Methodological notes

1. For the Menomonee River Watershed normalized loads (kg/ha) were desired. To get the variance associated with a normalized load, divide the square root of the mean squared error (standard deviation) by the same number that the load was divided by to normalize it.

2. Individual strata characteristics (i.e., the estimated load, variance, and df) can be combined to estimate loads, etc., for longer time periods; however, this combination is ordinarily not a simple summing and should, therefore, be done according to the accepted procedure (6).

To apply the stratified random sampling model in other watersheds (and for other parameters) after water quality samples have been collected without regard for strata, the following process should be used:

1. Determine what strata need to be designated on the basis of either the random sampling (within a stratum) assumption or the need for estimated loads for particular time periods.

2. Plot the concentration data for each period of interest versus instantaneous flow, with time (superimposed on the hydrographs for that period), and any other way considered informative in understanding the variation in concentration.

3. Examine the plots in order to determine whether concentrations vary more within an event (which would imply an event related stratification scheme, such as ascending versus descending hydrograph, or an event based cutoff flow) or from event to event (which would imply a seasonal cutoff flow.

4. Evaluate which general stratification scheme seems most appropriate given the amount of concentration data available and initial test results.

5. Calculate test loads and variances to determine which stratification scheme gives the most precise load, within the constraints listed for degrees of freedom.

Key Parameters

Two major types of pollution arising from nonpoint sources have been identified in the Great Lakes Basin, namely, nutrients and sediments which accelerate eutrophication of lakes and toxic materials which constitute a public health hazard and a hazard to the biological communities. The basic guidelines used in selecting key parameters for these types of pollution are 1. the pollutant must be present in significant amounts in the watershed and 2. it must be amenable to remedial control measures. The key parameters selected include suspended sediment; total phosphorus; toxic metals, primarily Pb, Cd, Cu, Zn; toxic organic materials, principally pesticides, PCBs and phenols; and fecal coliforms.

The parameters deemed to be of greatest importance in the Menomonee River Watershed are suspended sediment, total phosphorus and lead. Discussion of results will be focused primarily on these parameters.

I-4. RESULTS AND DISCUSSION

Flow and Concentration

Seasonal flow and concentration

Concentrations of the 26 parameters were monitored during runoff events and during baseflow (non-events) at the 12 mainstem river stations. The monitoring stations included nine automatic and three harbor grab sampling sites. Flow was recorded continuously at the automatic stations. Monitoring of flow and parameter concentrations was begun in 1975 and continued through the fall of 1977. The concentration data were compiled and stored in the U.S. EPA STORET system. Flow records were maintained on computer tape and are available from the WDNR. From 1975 to 1977 mean daily and monthly flow values were tabulated for each station in the U.S. Geological Survey Water Data Reports for Wisconsin (7-9).

Seasonal mean flows during events and baseflow at the automatic stations and the concentrations of 24 parameters at each of the 12 mainstem stations are presented in the Appendix (Tables I-A-1 to I-A-36). Data for temperature and pH was obtained during baseflow but is not tabulated in this report. Mean seasonal temperature during baseflow ranged from 0.3 to 9°C in winter and 19 to 23°C in summer; pH during the total period of observation ranged from 7.1 to 8.5. Concentration data presented in the tables include the number of samples (frequency) used in the calculation of the seasonal mean values and the standard deviation for each mean.

Seasons were defined as follows:

Summer - was the period from June 1 to September 30 of each year.
Fall - was the period from October 1 to December 21 of each year.
Winter - was the period from December 22 to the onset of spring.
Spring - was initiated by observing the onset of sustained high flows and varied from year to year and between stations in a particular year. Ranges of dates for the onset of spring were March 14 to March 20 in 1975, February 2 to February 17 in 1976 and February 22 to March 21 in 1977 and always terminated on May 31 of each year.

Concentration data at the automatic sampling stations and at the harbor grab sampling sites are discussed separately because of the differences in sampling techniques and the presence of lake effects (seiche) in the harbor. For illustrative purposes the key parameters--suspended solids, total-P, soluble-P and lead--are emphasized to show seasonal and site differences.

Automatic sampling stations

Seasonal mean event flow values were most often highest in spring. High spring flows may exert a significant impact on total water loading but this impact may be normalized by taking into account the number of event days. For example, in 1977 mean spring flows were higher than mean summer flows even though twice the number of event days were observed in summer.

Mean concentrations of suspended solids during events were usually highest in the summer. Except in 1977, lowest concentrations occurred in the fall; trends in 1977 were ill-defined because only a few samples were collected. For the entire study period high concentrations of total P occurred during at least two seasons and summer was always one of the seasons involved. For 1975 and 1976 comparable concentrations of total P were found in summer and fall. In 1977 these comparable concentrations occurred in summer and spring. High concentrations of soluble P were not observed consistently in any single season. Seasonal trends for lead are difficult to assess because only limited numbers of samples were analyzed. With the exception of station 673001, chloride concentrations were always high in spring because of road salt use in the winter; land uses tributary to station 673001 are largely rural. Unlike total- and soluble-P, high concentrations of suspended solids occurred only in summer. Because the peak of construction activities occurs during the summer it is probably of particular importance to provide sediment control measures during summer when high intensity rains are prevalent. The significance of the high summer concentrations of suspended solids is elaborated upon in the section dealing with loading data.

During events, parameter concentrations differed between stations during a particular season and for all seasons. However, similarities in mean concentrations exist at some stations as illustrated by the key parameters, thereby allowing ranking of the stations into low, intermediate and high flow or concentration groupings. Differences in flows between stations may contribute to variations in parameter concentrations. High mean seasonal flow values were usually observed at stations with large tributary areas. In general these stations exhibited low concentrations of suspended sediments. The relative pollutant concentration from each tributary area in the watershed is elucidated further in the discussion of loading data. At the three stations (673001, 683002 and 683001) located in the upper part of the watershed, low concentrations (based on mean values) of suspended solids were observed during all seasons. For all seasons, high concentrations of suspended solids were encountered at stations 413008, 413007 and 413006.

Low concentrations of total- and soluble-P were observed at all stations except 413009 and 683002. Total- and soluble-P concentrations were highest at station 413009 regardless of season. These high P levels can be attributed to the combined sewered area monitored at this station. Intermediate concentrations of total- and soluble-P were encountered usually at station 683002. These relatively high peak concentrations may reflect the impact of two sewerage treatment plants discharging above the station.

The mean Pb concentrations for all seasons were highest at stations 413007 and 413009, i.e., the more urbanized areas of the watershed. The lower concentrations were encountered at those stations tributary to the more rural areas. During periods of runoff, urban sources of suspended solids and lead appear to have a greater impact on the water quality of the river than do rural sources. Non point sources of total- and soluble-P--in urban and rural settings--appear to have minimal impact on concentrations of total- and soluble-P in the river.

Seasonal concentrations of parameters associated with particulate matter were usually higher during runoff events than during baseflow. This trend as exemplified by suspended solids, total-P and lead also occurred at all stations except at 673001 and 413006 for suspended solids and 683001 for total-P; at these three stations concentrations of these parameters were similar for events and baseflows. The importance of the non-point source contribution to the levels of particulate parameters in the river system is demonstrated clearly by the relatively high concentrations of suspended solids, total-P and lead during events.

In contrast, seasonal event concentrations of soluble parameters were either lower or similar to those observed during baseflow. At some stations--particularly 683001, 413005 and 413004--the baseflow concentrations of soluble-P were higher. High baseflow concentrations of soluble parameters may indicate point source contributions as shown by high soluble-P and ammonium-N concentrations at station 683001. This station is immediately downstream from the sewerage treatment plant in Menomonee Falls.

Inner harbor stations

Stations in the inner harbor include 413014 and 413013 located in the Menomonee River portion of the inner harbor which starts at the dam below Falk Corporation and ends at 2nd Street. Station 413012 lies just below the confluence of the Menomonee and Milwaukee Rivers.

Concentration data from the inner harbor stations provide an indication of water quality in the mixing zone between the Menomonee River and Lake Michigan. The inner harbor has a mean depth of 6 m and width of 60 m. Rapid mixing of the river and lake waters is restricted by a breakwater across the entrance of the harbor. A seiche effect has been evidenced at each of the inner harbor stations.

For most of the parameters during events, no consistent patterns in concentrations emerged between seasons. The mean event concentrations of suspended solids, total- and soluble-P for all seasons were similar at the three stations although variability was observed during some individual seasons. High concentrations of chlorides occurred in the spring and fall.

Parameters associated with particulate matter were always higher during events than during baseflow as evidenced by analysis of samples at the automatic stations. Overall, concentrations of soluble parameters were the same during events and baseflow. The baseflow levels of dissolved oxygen were much lower than levels during events in the summer and Fall. The dissolved oxygen dropped to levels considered critical for most fish species.

Comparison of concentration data showed that the mean event concentrations of suspended solids, total- and soluble-P and lead in the inner harbor for all seasons were higher than the levels observed in the nearshore zone of Lake Michigan (10). Mean seasonal concentrations of suspended solids during events were lower in the inner harbor than in the river; total- and soluble-P concentrations were similar in the two systems. Lead concentrations in the inner harbor were between the low concentrations found at the more rural stations and the high concentrations in the urbanized settings.

Bacteriological and organic pollutants

Bacterial counts were determined during baseflow events and runoff events at the automatic mainstem stations (Table I-A-37 and I-A-38). One grab sample was collected during three events and during baseflow for most of the stations. Even though there were only a limited number of samples examined the bacterial counts during events were always much higher than during baseflow. During events, bacterial counts usually were lowest at the predominantly rural stations (673001, 683002, 683001 and 413008). The fecal coliform:fecal streptococcus ratio was usually less than four at all stations. The ratio indicated that human wastes were not an important source of bacteria in the Watershed.

Organochlorine insecticides and PCBs were scanned during one event and two baseflow surveys. Concentrations were below detection limits in all samples.

Comparison of runoff and baseflow quality with water quality criteria

The overall mean values of event and baseflow concentrations of selected parameters at stations 413006 and 413005 were compared to water quality criteria (Table I-A-39). The stations selected for such evaluation were considered representative of urban land uses. The water quality criteria (11, 12) specify concentrations of contaminants that--if not exceeded--result in an aquatic ecosystem suitable for higher uses of the water. The criteria levels for domestic water supply incorporate the available data for human health protection. The criteria for freshwater aquatic life were chosen to offer a degree of safety for survival of fathead minnows in the Menomonee River. The metal values used for the water quality criteria represent soluble forms and are not directly comparable to the total metal concentrations determined at the mainstem stations. Usually, only a small percentage of the total metal is in soluble forms.

A potential exists for lead levels to exceed drinking water criteria, but not levels considered potentially hazardous to fathead minnows. The mean event concentrations of the other key parameters (suspended solids, total-P, and fecal coliform) exceeded acceptable levels for drinking water and/or freshwater aquatic life. The extremely high event fecal coliform counts especially demonstrated the potential impact of runoff events on the water quality of urban rivers.

Parameter concentration relationships

Correlation matrices relating flow, suspended solids, total- and soluble-P and chloride were determined at eight of the automatic mainstem stations for the spring and summer of 1977 (Table I-A-40). These seasons were represented by a relatively high number of samples, but lead was not among the parameters frequently analyzed. All the samples were collected during runoff events. A strong linear correlation was indicated between two parameters if the correlation coefficients were significant at probability levels of 0.05 or 0.01.

In most cases, a positive linear correlation was evident between flow and suspended solids. Only occasionally did significant correlations exist between total-P and flow. The soluble parameters--soluble-P and chloride--exhibited either low or negative correlations with flow. Negative relationships were observed more often between chloride and flow. The relationship between the parameters and flows was also observed in plots of the same seasonal data from stations 413006 and 413005 (Figs. I-A-1 to I-A-4). The plots also indicate that significant linear correlations exist between flow and some of the parameters at both stations. However, the significance of the correlation coefficient for suspended solids and total-P appear to depend upon the relatively low variability in the concentrations at lower flow values. A relatively high variability in concentrations at higher flows was less of a factor in the correlation coefficient, because most of the data points were in lower flow ranges. A similar problem was revealed in the flow to chloride correlations except the chloride concentrations demonstrated less variability in the high flows and when plots of concentrations and flow data used in the correlation analysis were made at stations 413006 and 413005, the same relationships existed (Figs. I-A-1 to I-A-4). However, the high correlation coefficients for suspended solids and total-P with flow appear to depend upon the relatively small variability in concentrations in the low flow ranges. Although large variability in concentrations occurred at higher flows it was less of a factor in determining the correlation coefficient, because most of the data points were in the lower flow ranges. A similar situation was evident for the chloride and flow correlations except that the chloride concentrations exhibited less variability at higher flows. The correlation coefficients would have more accurately described the relationship between the parameters and flow if the concentration data had been separated into two strata based on flow. The variability of the concentration values indicates the difficulty of using flow to predict concentrations of pollutants associated with particulates at higher flows and concentrations of some soluble parameters at low flows.

A highly significant linear correlation was observed between suspended solids and total-P concentrations at all stations during each season (Table I-A-40). The significant linear correlations between suspended solids and total-P values at all the stations indicate that a management strategy to control suspended solids will also reduce input of the parameters associated with the particulates. Metals such as lead would be included in the group of parameters likely to be controlled by management of suspended solids sources.

Relationships of flow, concentration and loading rate during events

Trends in the relationship of flow, concentration and loading rate during individual events are illustrated with data from a few well-sampled events. Patterns in flow, concentration and loading rates of suspended solids, total- and soluble-P, chloride and lead, during the course of an event were observed by plotting them against time (Figs. I-A-5 to I-A-14). Events were selected from stations 683001, 413007, 413006 and 413005. The loading rate was calculated by multiplying the flow and concentration values. Additional events were selected to demonstrate the concentration patterns of all the frequently analyzed parameters (Tables I-A-41 to I-A-46). Flow and time of sampling are included in the tables along with the concentration data. The relationships of flow, concentration and loading rates of suspended solids, total- and soluble-P and chloride during events were further characterized by determining relationships using simple regression and correlation analysis. To depict these relationships, data from two events at station 413006 and one event at station 413005 were plotted and regression equations and correlation coefficients determined (Figs, I-A-15 to I-A-23).

The levels of suspended solids, total-P, lead, and flow always increased significantly over baseflow levels during the course of an event (Figs. I-A-5 to I-A-14). Concentration curves for suspended solids, total-P and lead almost paralleled the hydrograph at all stations. In approximately 50% of the events evaluated, the concentration curves of suspended solids and total-P were shifted to the left of the peak of the hydrograph. Thus the peak concentrations were reached before the peak flow and decreased rapidly on the descending part of the hydrograph. Soluble P levels usually did not increase during events and the curves did not follow the shape of the hydrograph. The same pattern was observed in the mean seasonal concentrations discussed earlier. The variability in concentration values for these parameters reveals that a runoff event can only be characterized fully by sampling across the entire hydrograph. Loading rates of the three parameters followed the behavior of the hydrograph. It appears that flow has a greater influence on the loading rates of soluble-P than on concentration. The higher concentrations of total-P, suspended solids and lead during individual events again dramatize the important impact of urban runoff on river water quality. Similar results were observed for mean seasonal event concentrations.

Strong linear correlation was always observed between loading rates and flow for all parameters evaluated (Figs. I-A-18 to I-A-20). The relationships of suspended solids, total-P and chloride concentrations to flow (Figs. I-A-15 to I-A-17) and loading rates (Figs. I-A-21 to I-A-23) were less predictable. The concentrations of suspended solids and total-P were significantly correlated with flow and loading rates for one event at station 413006 but not for the other event evaluated. The concentrations of soluble-P and chloride were never correlated significantly with flow or loading rate. These results suggest that flow is more important to the determination of loading rate than the concentration of the parameter.

The degree of data points scatter determines the significance of the correlation coefficients. It is also important to note the variability in the values of the slopes and intercepts of the regression equation for the same parameter. Regression equations are probably not transferable from one event to another without averaging the slope and intercept values from a large number of events.

Monitored Loading Data

Seasonal loading

Seasonal water and other parameter loadings were determined for the mainstem river stations during runoff events and baseflow. Runoff event loadings do not include baseflow loadings during events and thus provide estimates of non-point source pollution from land use activities in the area tributary to each station. Seasonal baseflow loadings were added to the seasonal event loadings to estimate total seasonal loadings. The importance of non-point source pollution in the Watershed was determined by comparing total seasonal loadings with seasonal event loadings. Parameter loadings were determined using a random sampling technique enhanced by a ratio estimator. The method is described in the Materials and Procedures section. Water loadings were calculated by integration of flow values with time.

Seasonal event unit area loadings of parameters in water are presented in Tables I-A-47 to I-A-51. Parameter loadings were determined for suspended solids, total- and soluble-P and lead. The error estimator for each parameter loading is presented as the 95% confidence interval. The mean flow-weighted concentration for the season was calculated by dividing the seasonal event parameter loading by seasonal event water loading.

Parameter and water unit area loadings (unit loading will be used hereafter) varied for each season at the same station. Loadings also varied between years for the same station. Parameter and water unit loadings during fall were always lower than those observed during spring and summer. The trends between spring and summer unit loadings were less consistent. In 1976, the spring parameter and water unit loadings were significantly higher for most stations than summer loadings. However, summer unit loadings were higher than spring loadings in 1977. Unit loadings of suspended solids during spring and summer in 1975 were similar for most stations. Spring loadings were higher than summer loadings for those stations with significantly different suspended solids loadings in 1975. The number of groupings in each season for suspended solids unit loadings ranged from 3 to 6; total- and soluble-P unit loading estimates fall into 2 or 3 groups. Variations of unit loading estimates for total- and soluble-P between stations were less than those for suspended solids. Although the nine mainstem river stations can be ranked into groups, the stations found in each group can vary between seasons, years and parameters. Ranked groupings of stations for annual event unit loadings of 3 parameters are shown below. The Honey Creek station (413006) usually was amongst the stations included in the highest group for water and parameter unit loadings. The Honey Creek tributary area has the largest percentage of urban land uses; its connected imperviousness (28%) is high relative to the tributary areas of the other stations. The River Lane site (673001) was usually amongst the stations with lowest water and parameter unit loadings. The tributary area for the River Lane site contains the smallest percentage of urban land uses with very low connected imperviousness (1%). The non-point contribution unit area appears to be higher from the more urbanized tributary areas.

	Suspended solids		Total-P		Soluble-P	
Rank	1976	1977	1976	1977	1976	1977
1	413006	413006	683001 413008 413007 413006 413005	413006 413009	683001 413008 413005 413004	413009
2	413008	413008 413005	413004	683001 413008 413005 413004	673001 683002 413006	683001
3	413005 413004	683001 413007 413009 413004	673001 683002	673001 683002 413007	413007	673001 413006
4	683001 413007 413009	683002				683002 413007 413005 413004
5	683002	673001				413008
6	673001					

The seasonal and annual event unit water and parameter loadings were determined for the areas adjacent to stations at Pilgrim Road (683002), 124th Street (683001), 70th Street (413005), and Falk Corporation (413004) stations

(Table I-A-52). The adjacent area unit loadings were determined by subtracting the upstream event loadings from the downstream event loadings and dividing the difference by the area adjacent to the station. The adjacent area unit loadings for the stations (413007, 413006 and 413008) without upstream stations are presented in Tables I-A-47 to I-A-51. Based on the adjacent areas, the Menomonee Watershed can be divided into eight separate areas with independent loading values. Subtraction of areas of upstream stations for the 4 stations (683002, 683001, 413005 and 413004) listed in Table I-A-52 increases the percentage of urban land uses contributing to the stations. This is especially true for stations 413005 and 413004 which include all the more rural upper watershed in their tributary areas. The adjacent area unit loadings for the four stations were usually higher than the tributary area unit loadings. Increase in unit area loadings was variable; adjacent area unit loadings of suspended solids for several seasons increased more than twice over those of the tributary unit area loadings. By using the adjacent area unit loadings the ranking of the stations within a season is changed. In four of the nine seasons monitored, suspended solids unit loadings at 70th Street were high enough that the station was included in the highest ranked group. Caution must be used in the interpretation of the adjacent area data for the above four stations since large variances in the estimates of loadings produced several negative loading values. Also, an error estimate for the adjacent area unit loadings could not be determined. However, the results indicate that an increase in the percentage of urban land uses is accompanied by an increase in unit loadings.

The annual water, suspended solids and total-P loadings were determined for the three sewage treatment plants discharging into the Menomonee River and were compared to the annual event loadings (Table I-A-53). The annual non-point source pollution was significantly higher relative to the total (event plus baseflow) annual loadings than the point sources in the Menomonee River Watershed. The baseflow loading would account for the remainder of the total annual loadings. The relative point source contribution of total-P was much higher than the value for suspended solids. Other important point sources of pollutants to the Menomonee River are the 23 combined sewer overflow (CSO) outfalls between the Falk Corporation station (413004) and the confluence of the Menomonee and Milwaukee Rivers. The Milwaukee Metropolitan Sewerage Commission has estimated that approximately 2.0×10^4 kg of total-P and 1.6×10^6 kg of suspended solids are discharged annually from the 23 CSOs to the river. Direct comparison of the CSO loadings with average annual loadings is difficult because the CSO values include point and non-point contributions; however, they are important sources of pollution since the annual CSO loadings were of the same order of magnitude as the average annual event loadings.

Seasonal and annual total parameter and water loadings were determined by combining baseflow and event loadings (Tables I-A-54 to I-A-57). That portion of the total loading due to events was also calculated. Since the total loadings are not expressed as unit loadings, the ranking of the stations within a season is not possible because the magnitude of the loadings is related to the size of the tributary area. Highest loadings were always observed at the 70th Street site which drains most of the Watershed. As with the seasonal event unit loadings, total loadings were highest during the spring of 1976 and summer of 1977. The total water loading was always highest during the spring of 1975, but trends for suspended solids total loadings between spring and summer were variable. Since the fall total and unit loadings are always the lowest of any season, highest loadings occur either in spring or summer. The percentage of total loadings due to events is always highest for suspended solids; at most of the stations about 80% of the total suspended solids loadings was contributed by events. Far more of the total loadings of suspended solids and total-P was generated during events than was the case for water and soluble-P loadings. The data are consistent because of the relatively low suspended solids and total-P concentrations observed during baseflow surveys. Soluble-P concentrations during events were similar to baseflow values. Contributions of events to pollutant loadings differed between stations. The percentage of total parameter and water loadings contributed by events increased from the rural to the urbanized areas of the Watershed. The low event contribution observed at the River Lane station can be explained by the high perviousness and very low connected imperviousness of its tributary area. The relatively large amount of pervious area of this station reduces the amount of runoff. Approximately 50% or more of the annual parameter and water loadings at many of the stations monitoring urbanized areas is due to events.

The calculation of annual and seasonal event loadings included flow and concentration data from events of widely differing magnitudes. The events with exceptionally large amounts of rainfall appear to contribute a significant portion of the annual event loadings. Calculation of event data from 70th Street revealed that 48 and 59% of the total-P and suspended solids annual loadings, respectively, occurred during three rainfall events--namely, March 1 - 9 cm, April 23 - 7.5 cm and May 5 - 5 cm--in 1976. Two rainfall events--namely, June 6 - 5 cm and July 17 - 10 cm in 1977 accounted for 37 and 30% of the total-P and suspended solids annual event loadings, respectively.

Factors affecting loading

When analyzing the factors affecting loadings at the mainstem stations it is useful to differentiate between the two components of loading. Initially the runoff (water loading) and concentrations play dependent roles in the calculation of loadings. Evaluation of the impact of the factors on the loading components provides an understanding as to the manageability of nonpoint source pollution.

The most important hydraulic factor affecting urban runoff is the portion of impervious areas directly connected to the stream or drainage system. Most types of urban development in the Menomonee River Watershed have impervious areas directly connected to a subsurface storm sewer system which drains to a stream. The street surfaces and parking lots are usually about 90% connected and rooftops about 25% connected to a storm sewer. The results of connecting impervious areas to storm sewers or rivers is to increase the amount and intensity of runoff. This result was observed in the seasonal unit water loading data. The highest unit water loadings were associated with the station (413006) having the largest percentage of connected impervious area. This relationship was shown further when unit loadings were calculated based on areas adjacent to the station. Other hydraulic factors included slope, rainfall intensity, soil permeability, land cover and depression storage. These factors have greater influence on runoff quantity from pervious areas than from impervious areas. All of the tributary areas for the mainstem sites contain large amounts of pervious area. Thus the observed seasonal unit water loadings were affected by all the above hydraulic factors. Management of the factors controlling urban runoff would be difficult or impossible. Reducing the degree of connected impervious area would be most beneficial in developing areas.

The concentration component is largely affected by the land use activities. The potential amount of material available for transport is determined by land use activities. Construction activities disturb vegetative cover and expose soils to erosion. Heavy traffic and air pollution in industrial, commercial and residential areas increase the accumulation of pollutants on impervious areas. The observed increases in concentration of suspended solids, total-P and lead during events revealed that a source of these pollutants existed in the tributary areas of the mainstem stations. Because of the multiple land uses in each tributary area, attempts to isolate the important sources of these pollutants is difficult. It is assumed that the largest source of suspended solids in an urban area is construction sites while lead originates largely from vehicular emissions deposited in streets and parking lot surfaces. The fact that chloride concentrations only increase in spring indicates that road salting is the only important source of this contaminant. Factors affecting delivery of pollutants are important in controlling the concentrations of materials transported. Hydraulic factors affect the transport of pollutants. Increasing the amount of runoff by any of the hydraulic factors will increase the transport of many of the pollutants. Large areas of connected imperviousness affect the transport of pollutants from urban areas by increasing scouring energy and velocity of overland flow. Thus, both the hydraulic factors and land activities contributing to high concentrations of pollutants should be considered in the development of a management strategy for urban areas. Both components of parameter loadings affect the level of non-point source pollution, but runoff may exert a greater influence than concentration.,

The relationship of runoff to parameter loadings is demonstrated in Figs. I-A-24 to I-A-30. The parameter loading was almost always highly correlated to the water loading. Loadings of suspended solids, total- and soluble-P for seasonal and individual events usually increased with increasing runoff for all four stations evaluated. As mentioned earlier the most important hydraulic factors affecting urban non-point pollution is the degree of connected imperviousness. Correlation analysis showed that the seasonal suspended solids, total-P and water loadings were related significantly to the percent connected imperviousness for the spring and summer of 1977 (Figs. I-A-31 to I-A-34). This relationship was not observed consistently in 1975 and 1976. The variability in the relationships in different years is probably due to the effect of both the hydraulic factors related to the amount of runoff on the pervious areas and the small range in connected impervious areas for seven of the mainstem river stations. The importance of the degree of connected imperviousness is sometimes masked by the large amounts of rural pervious areas in each of the tributary areas.

The results reveal the importance of a remedial policy based on controlling hydraulic factors that are manageable. However, a policy to control the transport of pollutants would be shortsighted if it did not also include the control of sources of high pollutant concentrations. Implementation of erosion control practices at construction sites is an obvious example.

Controlling hydraulic factors will involve long term policies which involve reduction of connected imperviousness in developing urban areas.

Rainfall-Runoff Relationship

Rainfall events and snowmelt generate runoff and pollutant washoff but amounts of runoff and pollutant loadings are not always correlated significantly with the amount of rainfall. This relationship of runoff and event suspended solids with rainfall for seasonal and individual events is demonstrated in Figs. I-A-35 to I-A-38. Data for the individual events are presented in Table I-A-58. Of the four mainstem river stations (683001, 413007, 413006 and 413005) evaluated runoff was correlated significantly only with rainfall at the Honey Creek (413006) station. The relatively high amount of connected imperviousness at station 413006 probably explains the high correlation. The seasonal event loadings of suspended solids were highly correlated with rainfall for stations at 70th Street (413005) and River Lane (673001) but not for stations at Honey Creek (413006) and Underwood Creek (413007). In contrast, the individual event suspended solids loading was highly correlated with rainfall for the three stations (683001, 413006 and 413005) evaluated. The general lack of significant correlation between runoff and rainfall is attributed to other hydraulic and hydrologic factors affecting runoff from pervious areas. Factors like evapotranspiration, soil permeability and rainfall intensity will affect runoff differently throughout the year and cause the observed variability in the relationship between runoff and rainfall at stations with tributary areas having a large degree of pervious surface. For example, evapotranspiration will reduce the amount of runoff more in the summer than in the spring. The tributary areas with a large percentage of connected imperviousness would be expected to show a more significant relationship between runoff and rainfall, as was observed at station 413006.

The effect of hydraulic and hydrologic factors on runoff is further demonstrated by observing the relationship between percentage runoff and rainfall amount for each season (Table I-A-59). More rainfall occurred in the summer of 1975 than in the spring, but the spring evinced a higher runoff percentage. In 1977, summer had higher rainfall than spring but the runoff percentages were similar for both seasons. Furthermore, spring 1976 had the highest rainfall and percent runoff values. Again factors affecting runoff in pervious areas including evapotranspiration, rainfall intensity, depression storage, and soil permeability would account for the variability in the relationship between percent runoff and rainfall. Even with lower rainfall these factors could result in percent runoff values at least similar to those observed in summer. Spring is characterized by more saturated soil conditions because of such phenomenon as snowmelt, and lower evapotranspiration rate. The presence of frost in the soil at the onset of spring will also increase runoff in this season. Approximately 10 cm of rain fell on frozen ground in 1976 and about 3 cm in both 1975 and 1977. The stations with the lowest connected imperviousness area usually had the lowest percentage runoff. The trends in rainfall amounts during the spring and summer of 1976 and 1977 were similar to the trends observed for the seasonal event parameters and water loadings. The rainfall amounts and loadings were highest in the spring of 1976 and summer of 1977. As previously discussed, the water and pollutant loadings do not always have a significant correlation to rainfall when all the seasons are included in the evaluation of each station.

First Flush Analysis

Previous urban monitoring programs have observed a first flush phenomenon, or the passage of the largest percentage of the pollutants in the early part of an event. As defined in this study, first flush occurs when the percent of the total parameter load discharged exceeds by more than 20% the corresponding percent of total water discharged. The comparisons are valid at any point in the event before 50% of the water is discharged. A first flush will occur if exceptionally high pollutant concentrations occur before peak flows are reached.

The first flush analysis for two events at station 413005 and 413006 are presented in Table I-A-60. A first flush was evident for suspended solids and total-P during some events but none was observed for soluble-P. Thus a moderate first flush probably occurs sometimes at the mainstem river stations. The observed first flush probably has limited application to a remedial program.

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APPENDIX A. MONITORING DATA AT MIXED LAND USE SITES

Appendix I-A contains tabular and pictorial materials which are grouped in the following manner to correspond to the order shown in the main text.

Table or Figure Nos.	Description
Tables I-A-1 to I-A-36	Flow of water and concentration of parameters at the mainstem river stations during non-events (baseflow) and events.
Tables I-A-37 and I-A-38	Bacterial counts in non-event and event samples at the mainstem river stations.
Table I-A-39	Comparison of mean concentration of selected parameters in the Menomonee River with water quality criteria.
Table I-A-40	Correlation coefficients (r) for water quality concentrations.
Figs. I-A-1 to I-A-4	Relationships of event flow and parameter concentrations during spring and summer of 1977 at two mainstem river stations.
Figs. I-A-5 to I-A-14	Flow and parameter concentrations and loading rates for different events at various mainstem river stations.
Tables I-A-41 to I-A-46	Flow and parameter concentrations for selected events at various mainstem river stations.
Figs. I-A-15 to I-A-23	Relationships of parameter concentrations and loading rates with flow and loading rates with concentrations for different events at various mainstem river stations.
Tables I-A-47 to I-A-51	Seasonal and annual event unit area loadings of water and various parameters for tributary areas to the mainstem river stations.
Table I-A-52	Seasonal and annual event unit area loadings of water and various parameters for areas adjacent to the mainstem river stations.

Table or Figure No.	Description
Table I-A-53	Relative contributions from non-point and point sources of pollution in the Menomonee River Watershed.
Tables I-A-54 to I-A-57	Seasonal and annual total loadings of water and various parameters for the tributary areas to mainstem river stations.
Figs. I-A-24 to I-A-30	Relationships of parameter and water loadings at selected mainstem river stations.
Figs. I-A-31 to I-A-34	Relationships of parameter and water loadings with degree of connected imperviousness.
Figs. I-A-35 to I-A-38	Relationships of runoff and parameter loadings with rainfall at selected mainstem river stations.
Table I-A-58	Rainfall, runoff and parameter loadings at various mainstem river stations for selected events.
Table I-A-59	Seasonal and annual rainfall and runoff at the mainstem river stations.
Table I-A-60	Relationships of water and parameter loadings during events at selected dates and stations.

Table I-A-1. Seasonal mean flow (cms) during non-events and events at main stem river stations

STORET Number	SPR 75	SUM 75	FALL 75	SPR 76	SUM 76	FALL 76	SPR 77	SUM 77	FALL 77
					Non-event				
673001	0.54 (50.6)*	0.15 (96.5)	0.15 (60.8)	0.94 (100.2)	0.09 (117.5)	0.06 (80.0)	0.23 (76.0)	0.19 (93.7)	
683002	1.21 (47.2)	0.24 (86.8)	0.27 (58.5)	0.94 (54.9)	0.11 (114.6)	0.09 (78.9)	0.29 (67.0)	0.25 (97.6)	
683001	1.33 (37.1)	0.37 (70.7)	0.50 (70.5)	1.60 (43.6)	0.22 (105.1)	0.17 (74.2)	0.47 (60.0)	0.51 (88.8)	0.99 (74.8)
413008	0.42 (39.4)	0.10 (80.5)	0.11 (53.5)	0.39 (45.7)	0.04 (108.8)	0.02 (75.2)	0.11 (55.5)	0.08 (80.5)	
413007	0.32 (54.4)	0.12 (102.4)	0.06 (67.6)	0.34 (57.2)	0.07 (113.8)	0.04 (77.8)	0.09 (70.4)	0.08 (94.7)	0.12 (75.9)
413006	0.11 (51.2)	0.09 (92.5)	0.06 (60.7)	0.12 (72.1)		0.04 (75.8)	0.08 (70.4)	0.08 (89.3)	0.06 (73.6)
413005	2.13 (27.5)	0.87 (68.0)	0.91 (61.9)	2.57 (45.9)		0.40 (73.0)	0.92 (61.7)	0.88 (74.8)	1.64 (72.9)
413004			1.08 (58.0)	3.16 (43.8)			1.19 (62.7)	1.08 (74.6)	
					Event				
673001	2.21 (24.9)	0.44 (25.5)	0.47 (20.2)	1.48 (19.2)	0.24 (4.5)	0.23 (1.0)	0.68 (14.0)	0.62 (28.3)	
683002	3.90 (28.3)	1.09 (35.2)	1.16 (18.9)	3.35 (50.1)	0.35 (7.5)	0.25 (2.1)	1.42 (12.1)	1.04 (24.2)	
683001	5.48 (35.2)	1.71 (51.3)	3.14 (10.5)	5.77 (65.6)	0.54 (16.9)	0.41 (6.8)	2.04 (30.0)	1.53 (33.2)	3.00 (7.2)
413008	2.12 (38.2)	0.70 (41.5)	0.54 (27.5)	2.21 (65.0)	0.28 (13.2)	0.16 (5.8)	0.67 (16.5)	0.27 (41.5)	
413007	1.93 (24.2)	1.09 (19.6)	0.46 (13.4)	1.28 (50.4)	0.60 (8.2)	0.50 (3.2)	0.42 (16.6)	0.57 (27.3)	0.80 (6.1)
413006	1.03 (24.2)	0.50 (29.5)	0.47 (17.0)	1.47 (40.4)	0.67 (15.7)	0.60 (5.4)	0.75 (19.6)	0.93 (32.7)	0.77 (8.4)
413005	9.86 (50.0)	3.90 (54.0)	4.10 (16.1)	9.39 (73.6)	2.34 (16.0)	1.64 (8.0)	4.12 (21.2)	3.28 (47.2)	4.08 (9.1)
413009				0.16 (7.5)	0.21 (7.5)	0.11 (1.2)	0.11 (3.5)	0.16 (4.2)	
413004			4.04 (20.2)	10.50 (69.7)	2.68 (15.7)		4.35 (21.3)	3.66 (47.4)	

*( ) Duration (days) of either low (non-event) and high (event) flows during a season.

Table I-A-2. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for dissolved oxygen during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	ALL SEASONS
					Frequency					
673001	9.	13.	9.	9.	11.	10.	6.	2.		69.
683002	8.	13.	9.	8.	11.	10.	7.	3.		69.
683001	9.	18.	7.	7.	13.	10.	4.	4.		72.
413008	7.	16.	9.	7.	15.	8.	7.			69.
413007	7.	16.	9.	7.	15.	10.	5.			69.
413006	8.	15.	7.	7.	13.	8.	5.			63.
413005	7.	17.	9.	11.	13.	9.	5.	2.		73.
413004	7.	16.	7.	8.	13.	9.	5.	5.		70.
413012	3.	15.	6.	6.	21.	15.	12.	12.	9.	99.
413013	3.	16.	6.	6.	21.	15.	12.	12.	19.	110.
413014	3.	16.	6.	6.	21.	15.	12.	12.	18.	109.
					Mean concentration					
673001	9.79	11.49	9.31	9.88	10.55	10.32	14.12	8.46		10.59
683002	10.42	8.84	11.30	12.07	10.78	7.99	10.70	7.87		10.05
683001	10.62	8.42	10.01	10.49	11.60	8.75	9.60	4.07		9.50
413008	10.90	7.49	10.18	10.61	10.58	7.40	7.50			9.17
413007	13.31	15.10	15.21	14.71	12.48	12.15	13.36			13.77
413006	12.19	10.22	11.14	12.51	11.92	9.99	11.66			11.26
413005	11.16	11.56	14.37	12.93	11.78	11.77	13.48	9.85		12.22
413004	8.10	7.82	8.80	10.99	11.19	6.22	9.14	10.04		8.98
413012	9.93	4.51	3.65	10.77	8.92	4.20	4.73	9.87	6.56	6.75
413013	5.30	3.22	1.87	9.78	7.13	2.99	3.84	8.08	4.88	5.16
413014	6.77	2.52	1.15	8.65	6.90	1.13	2.91	6.60	2.57	4.05
					Standard deviation					
673001	1.31	3.37	1.08	.83	1.02	2.28	4.51	1.77		2.31
683002	1.51	.49	1.32	1.01	1.54	.94	1.04	5.49		1.51
683001	2.11	.95	1.39	.93	1.30	1.27	2.17	1.73		1.40
413008	1.83	.93	2.22	1.14	.77	1.19	3.19			1.60
413007	2.34	2.59	.79	3.29	1.11	1.61	2.81			2.11
413006	1.66	.93	.64	.60	.96	.62	1.55			1.03
413005	.74	1.57	2.99	.65	1.01	3.11	1.42	.35		1.82
413004	3.31	1.64	1.60	.22	1.37	.94	1.32	.52		1.60
413012	.25	1.87	.61	.66	2.97	2.23	2.55	1.37	1.26	2.12
413013	.40	1.85	.45	.75	3.06	1.83	2.84	.81	1.95	2.13
413014	1.50	2.69	1.03	.44	3.80	1.45	2.23	1.37	1.12	2.31

Table I-A-3. Seasonal mean conductivity (μmhos/cm), standard deviations and frequency of sampling during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	ALL SEASONS
Frequency										
673001	9.	13.	9.	9.	11.	10.	6.	3.		70.
683002	8.	13.	9.	8.	11.	10.	7.	3.		69.
683001	9.	17.	7.	7.	13.	10.	4.	5.		72.
413008	7.	15.	9.	7.	15.	8.	7.	3.		71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		69.
413006	8.	14.	6.	7.	13.	8.	5.	1.		62.
413005	7.	16.	9.	11.	14.	9.	5.	3.		74.
413004	7.	15.	7.	8.	13.	9.	5.	5.		69.
413012	3.	14.	6.	6.	17.	15.	12.	12.	9.	94.
413013	3.	15.	6.	6.	18.	15.	12.	12.	19.	106.
413014	3.	15.	6.	6.	18.	15.	12.	12.	19.	106.
Mean concentration										
673001	681.11	755.38	676.67	602.22	505.45	851.00	716.67	690.00		684.29
683002	675.00	747.69	682.22	636.25	589.09	808.00	775.71	893.33		710.43
683001	791.11	925.88	916.43	838.57	676.15	1339.00	1027.50	1140.00		932.43
413008	2087.14	871.33	682.22	800.00	693.33	710.00	827.14	2100.00		951.97
413007	1168.57	1145.33	973.33	2461.43	1430.67	1174.00	898.00	1080.00		1306.09
413006	1111.25	848.57	600.00	2641.43	1501.54	880.00	846.00	2300.00		1225.00
413005	944.29	996.25	884.44	1114.55	763.57	1098.89	936.00	1310.00		972.43
413004	917.14	884.00	781.43	1263.75	840.77	891.11	836.00	1048.00		922.17
413012	420.00	461.43	448.33	661.67	479.41	400.00	477.50	530.00	541.11	483.94
413013	670.00	505.33	578.33	838.33	637.78	464.00	542.50	782.50	565.26	595.94
413014	843.33	680.67	660.00	916.67	716.67	626.67	605.83	627.75	717.37	688.05
Standard deviation										
673001	115.91	74.23	119.06	17.16	120.36	53.64	44.12	52.91		87.57
683002	93.96	41.26	66.67	69.68	134.87	37.95	141.87	115.90		90.01
683001	181.41	163.56	259.85	66.69	214.26	135.52	140.56	85.73		173.57
413008	3445.75	90.23	91.21	132.41	259.14	167.16	428.51	173.20		1082.49
413007	192.30	140.25	120.21	2063.35	872.95	178.21	161.77	.00		781.09
413006	131.52	171.77	149.53	1897.05	647.12	194.94	664.59	.00		736.20
413005	159.57	111.53	140.72	285.63	304.47	55.33	227.00	294.62		210.45
413004	115.14	91.32	80.50	269.55	521.99	69.18	134.28	290.29		270.43
413012	.00	138.89	33.12	49.57	103.41	79.64	80.92	156.90	144.35	110.50
413013	132.29	122.47	21.37	51.93	144.25	65.11	64.26	95.45	167.34	116.81
413014	45.09	121.92	36.33	21.60	136.12	157.28	118.51	307.70	202.37	170.37

Table I-A-4. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total solids during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		4.	74.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	71.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	14.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	76.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	17.	9.	5.	3.	2.	10.	89.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
					Mean concentration						
673001	591.33	573.23	624.22	617.33	485.36	611.40	707.50	732.67		555.00	595.46
683002	[illegible]84.25	647.31	571.33	641.00	505.27	554.50	670.00	767.00		662.50	602.51
68 001	683.11	744.12	782.86	852.00	611.15	954.82	963.75	1185.20	1200.00	833.33	812.45
413008	760.29	711.87	680.44	934.57	715.73	521.87	869.29	2126.00			789.30
413007	1016.00	867.87	880.89	2601.14	1370.80	8[illegible]5.60	927.00	1346.00		550.71	1120.00
413006	915.50	582.43	478.57	2659.14	1458.85	560.78	840.00	2306.00		516.11	994.59
413005	793.43	749.31	758.67	1213.82	744.24	789.33	947.00	1399.00	1210.00	627.50	843.89
413004	747.14	663.00	639.43	1237.75	788.85	620.89	767.00	1040.20		548.00	772.59
413012	416.67	325.29	317.67	632.67	414.38	260.06	380.83	489.17	601.67		390.88
413013	605.33	344.07	398.00	766.33	519.48	290.67	417.92	673.75	613.33		469.21
413014	782.00	463.64	467.67	890.33	640.90	406.39	479.58	774.58	906.67		584.52
					Standard deviation						
673001	47.06	79.60	35.99	20.59	60.90	56.03	60.72	81.98		10.80	56.17
683002	47.96	175.42	22.47	20.84	64.44	38.41	73.03	83.47		10.61	89.20
683001	86.50	71.64	59.26	52.22	184.35	119.57	99.28	139.37	162.64	142.24	115.32
413008	55.97	136.46	127.76	102.19	248.61	105.15	494.30	95.27			214.53
413007	109.96	116.55	103.79	2064.15	962.19	115.36	108.84	.00		202.23	765.75
413006	118.23	126.22	157.06	1897.69	852.33	152.35	694.68	.00		166.26	719.32
413005	72.34	82.55	30.02	306.10	260.61	41.87	273.62	292.56	148.49	83.18	186.01
413004	44.94	69.34	37.66	357.23	449.14	47.23	146.65	271.79		66.58	242.39
413012	9.02	75.16	18.57	26.25	58.08	39.85	113.60	131.23	7.64		76.61
413013	126.72	70.32	4.19	20.22	109.49	39.68	106.67	50.05	127.41		79.89
413014	13.86	78.01	30.29	41.13	121.66	126.80	157.50	96.38	105.04		110.97

Table I-A-5. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total solids during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	15.	10.	4.	5.			33.	11.	78.
683002	15.	12.	4.	5.			25.	31.	92.
683001	15.	10.	6.	14.	23.	11.	55.	57.	191.
413008	16.	11.	4.	3.		12.	37.	14.	97.
413007	16.	10.	4.	8.		4.	30.	33.	105.
413006	15.	10.	6.	16.	33.	29.	69.	69.	247.
413005	16.	32.	4.	85.	37.	26.	73.	74.	347.
413009				3.	21.		44.	17.	85.
413004	16.	11.	6.	3.	2.	2.	37.	39.	116.
413012	29.	13.	13.	6.			2.	6.	69.
413013	30.	12.	12.	6.	6.	2.	2.	8.	78.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.
				Mean concentration					
673001	479.47	558.40	546.00	507.80			708.94	639.09	614.41
683002	505.33	579.92	505.50	600.80			662.40	558.06	580.70
683001	576.80	682.50	541.67	595.71	843.74	824.00	851.09	831.75	784.06
413008	660.87	645.55	619.50	837.00		384.58	1220.38	627.86	837.35
413007	958.50	805.20	859.00	772.75		1291.25	1434.60	780.97	1018.86
413006	1061.07	583.80	510.00	569.37	435.85	377.59	963.42	661.52	693.84
413005	703.50	617.09	643.00	716.51	859.70	617.12	974.78	757.64	776.82
413009				543.00	323.05		721.77	531.18	578.83
413004	674.12	602.91	592.00	839.33	310.00	362.50	817.81	579.36	669.72
413012	410.34	329.23	445.08	564.50			595.00	391.67	418.74
413013	504.00	359.33	495.83	781.17	292.50	337.50	615.00	315.62	464.79
413014	620.07	453.17	574.33	645.17	272.50	302.50	612.50	328.75	524.33
				Standard deviation					
673001	116.73	53.18	68.72	89.15			84.42	79.99	87.73
683002	89.07	83.11	18.72	15.83			101.68	104.21	94.19
683001	123.96	93.68	46.17	96.91	247.92	100.73	150.31	243.57	187.35
413008	122.71	82.60	123.50	232.63		42.45	571.66	263.20	382.00
413007	347.25	187.37	363.08	253.67		577.51	1459.40	1080.11	1025.54
413006	711.52	177.60	370.39	364.4	216.59	109.01	847.23	380.23	543.22
413005	107.88	137.94	251.68	117.42	417.16	130.17	281.77	353.06	272.12
413009				64.78	208.37		570.82	397.93	463.76
413004	106.63	104.17	116.66	190.38	35.36	123.74	189.53	159.79	158.10
413012	62.92	55.39	72.52	37.05			7.07	239.62	89.51
413013	111.38	119.44	122.05	25.02	26.97	24.75	21.21	25.28	99.49
413014	185.39	88.87	104.84	43.27	33.87	17.68	3.54	57.43	133.26

Table I-A-6. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for suspended solids during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	FALL77	ALL SEASONS
Frequency												
673001	21.	47.	42.	31.	144.	57.	40.	19.	33.	30.	2.	466.
683002	19.	68.	32.	17.	124.	63.	21.	15.	13.	24.	2.	398.
683001	20.	68.	32.	10.	181.	81.	40.	33.	52.	37.	2.	556.
413008	7.	53.	46.	31.	188.	58.	13.	8.	37.	38.	2.	491.
413007	9.	22.	15.	18.	72.	30.	24.	2.	13.	20.	2.	227.
413006	10.	24.	10.	7.	212.	48.	30.	2.	16.	56.	10.	425.
413005	18.	27.	12.	14.	318.	38.	10.	25.	18.	38.	14.	532.
413009					107.	30.		2.		4.	1.	144.
413004	7.	15.	18.	30.	187.	92.	6.	5.		5.	2.	367.
413012	3.	14.	6.	6.	21.	18.	12.	12.	13.			105.
413013	3.	15.	6.	6.	21.	18.	12.	12.	19.			112.
413014	3.	15.	6.	6.	21.	18.	12.	12.	19.			112.
Mean concentration												
673001	36.62	30.30	53.17	26.45	22.81	31.79	48.50	26.37	39.70	44.10	96.50	33.50
683002	16.89	23.10	6.56	33.24	23.26	15.68	26.10	27.00	9.31	13.00	145.00	20.64
683001	24.55	51.74	13.47	11.30	28.25	38.78	18.45	15.24	24.77	100.24	162.50	34.84
413008	22.00	35.47	34.61	38.94	106.64	48.33	43.08	20.12	16.95	421.00	136.50	92.71
413007	34.56	21.05	12.00	53.28	54.74	33.63	109.92	29.00	27.00	61.75	94.50	49.93
413006	9.50	3.92	3.00	5.29	296.13	110.35	56.00	17.50	14.44	238.37	196.70	201.40
413005	19.72	23.70	15.50	14.43	47.63	67.74	25.90	57.16	18.22	100.11	100.29	49.49
413009					163.38	79.03		27.50		179.00	135.00	144.16
413004	9.71	13.13	11.78	42.67	40.74	23.13	5.17	10.00		56.20	105.00	32.90
413012	10.33	17.29	9.83	9.83	18.19	9.56	18.00	10.92	31.08			16.15
413013	20.67	18.27	8.00	12.00	24.90	10.67	21.83	12.17	28.63			18.96
413014	13.00	20.67	11.17	7.33	39.00	35.89	16.33	16.08	36.00			26.77
Standard deviation												
673001	25.42	17.04	45.78	22.69	17.52	18.05	46.97	28.30	52.89	31.49	10.61	29.97
683002	13.98	27.29	7.18	40.33	27.15	22.53	42.13	35.35	7.76	9.41	65.05	26.08
683001	14.91	32.06	3.31	8.93	35.95	16.00	12.14	16.26	16.44	56.25	79.90	29.54
413008	12.43	18.32	17.86	32.35	181.42	59.59	58.01	26.81	14.54	489.63	16.26	178.81
413007	32.25	42.69	16.00	40.76	95.65	80.79	132.34	11.31	34.61	121.77	7.78	86.50
413006	12.58	7.34	3.09	8.04	329.37	254.43	65.31	16.26	8.57	245.27	175.34	267.60
413005	30.54	17.53	13.69	7.28	55.13	94.34	23.73	60.03	9.23	154.95	98.30	68.24
413009					230.10	102.06		24.75		81.19	.00	206.63
413004	2.36	9.99	14.19	123.53	69.24	54.86	2.14	8.46		40.28	28.28	67.38
413012	1.53	5.37	2.56	4.12	6.16	3.35	8.67	2.71	37.83			14.26
413013	1.16	5.31	2.53	6.54	22.72	5.58	13.92	2.25	54.71			25.61
413014	1.73	20.99	5.64	1.03	37.21	54.83	10.09	18.10	44.11			34.82

Table I-A-7. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for suspended solids during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	FALL77	ALL SEASONS
					Frequency					
673001	181.	156.	27.	79.	15.	5.	90.	56.		609.
683002	173.	197.	47.	70.	32.	7.	58.	112.		696.
683001	190.	219.	24.	133.	73.	30.	151.	166.		986.
413008	108.	220.	60.	114.	38.	32.	100.	62.	1.	731.
413007	274.	98.	8.	47.	28.	13.	74.	106.	1.	649.
413006	98.	308.	18.	189.	113.	75.	195.	253.		1249.
413005	213.	329.	55.	279.	97.	39.	127.	264.	3.	1406.
413009		1.	41.	78.	95.		108.	39.		362.
413004	16.	12.	33.	47.	9.	2.	37.	63.		219.
413012	29.	13.	13.	6.			2.	6.		69.
413013	30.	12.	12.	6.	6.	2.	2.	8.		78.
413014	30.	12.	12.	6.	6.	2.	2.	8.		78.
					Mean concentration					
673001	30.60	41.85	51.15	24.70	32.40	19.80	25.16	68.14		36.23
683002	43.95	73.07	31.11	40.57	49.25	19.00	42.57	102.51		60.29
683001	55.63	149.58	34.21	67.77	117.01	25.27	114.17	224.27		118.59
413008	98.56	247.90	93.02	218.60	349.71	68.41	345.38	236.05	411.00	219.36
413007	315.64	358.60	29.12	131.72	197.29	364.00	214.04	191.49	46.00	268.86
413006	283.47	180.50	90.72	184.85	166.58	62.55	213.30	275.77		204.02
413005	58.09	2[illegible]0.16	86.31	138.24	290.02	72.87	144.06	256.30	139.67	177.42
413009		55.00	84.80	144.86	135.11		155.95	251.85		150.09
413004	46.19	82.25	23.30	133.64	53.22	123.00	113.14	176.14		113.17
413012	30.86	29.62	13.92	55.33			78. 0	133.67		39.87
413013	34.67	57.50	14.25	42.67	16.33	22.50	48.00	46.37		35.47
413014	24.30	45.67	16.08	89.33	35.00	19.50	47.00	81.12		38.44
					Standard deviation					
673001	19.25	24.70	25.21	18.93	13.36	6.46	19.94	83.53		32.31
683002	27.52	92.42	19.47	26.26	67.60	11.16	40.98	97.16		67.80
683001	55.97	132.27	46.28	92.60	178.28	18.13	160.92	253.25		151.18
413008	167.71	387.32	106.16	295.63	616.20	58.21	470.18	274.35	.00	346.98
413007	504.51	468.15	16.93	118.05	322.45	460.24	360.74	535.56	.00	461.58
413006	358.29	196.68	98.65	150.05	179.39	73.48	458.60	318.46		282.57
413 05	75.14	149.14	100.80	130.21	318.40	71.21	161.77	293.06	23.63	188.36
413009		.00	122.68	118.88	150.40		196.42	264.10		172.52
413004	84.33	103.52	39.22	200.69	58.15	103.24	152.18	166.39		149.48
413012	20.83	12.07	5.38	25.60			14.14	203.31		59.68
413013	26.06	69.94	6.36	3.01	3.20	7.78	2.83	37.53		34.64
413014	21.62	46.33	10.66	49.87	21.02	2.12	2.83	44.75		30.96

Table I-A-8. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for volatile suspended solids during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		4.	74.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	71.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	76.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	17.	9.	5.	3.	2.	11.	90.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	4.		96.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	7.67	15.69	8.67	4.11	5.82	15.20	9.83	8.67		7.75	9.73
683002	4.75	9.46	3.11	3.37	6.09	5.10	4.00	5.00		6.00	5.48
683001	6.11	11.76	4.86	3.00	6.23	10.82	9.25	6.80	9.00	19.33	8.55
413008	2.57	5.93	4.00	3.14	7.73	7.25	5.43	1.67			5.38
413007	11.00	6.40	3.22	4.71	9.47	4.30	8.40	3.00		14.00	7.41
413006	2.37	1.50	1.86	1.86	7.46	6.56	2.20	3.00		18.33	5.45
413005	7.29	5.94	5.56	3.45	10.00	12.78	5.60	4.67	6.50	11.45	7.78
413004	3.86	4.87	5.71	10.12	6.92	5.78	4.20	6.20		22.20	7.11
413012	4.67	5.14	4.67	3.33	4.62	5.33	5.42	5.25	2.25		4.83
413013	6.67	6.13	4.50	4.00	4.67	5.72	5.67	5.25	1.33		5.20
413014	4.67	6.60	5.50	2.83	7.24	9.11	5.33	5.42	2.67		6.42
					Standard deviation						
673001	6.12	12.47	4.65	2.09	3.34	6.91	4.40	3.51		.50	6.84
683002	5.15	8.19	2.09	1.61	3.36	2.56	3.22	1.73		.00	4.59
683001	3.85	6.42	2.48	2.24	2.39	6.10	6.29	9.31	.00	.58	5.07
413008	.98	3.62	1.87	2.48	3.94	3.84	4.28	.58			3.29
413007	8.50	9.02	2.91	4.42	7.46	4.03	7.67	.00		9.95	7.24
413006	1.77	1.29	1.57	2.03	6.88	10.78	.84	.00		9.90	6.08
413005	4.42	3.28	5.03	1.86	6.57	8.97	3.78	1.16	.71	6.11	5.34
413004	1.34	3.14	4.42	18.57	3.55	3.19	2.39	4.60		18.06	8.16
413012	1.16	2.38	3.01	.82	1.50	2.70	2.47	1.14	2.63		2.13
413013	.58	3.44	2.74	.00	1.91	3.21	2.35	1.14	.58		2.46
413014	1.16	5.74	3.21	.75	5.20	6.43	2.27	3.00	1.53		4.70

Table I-A-9. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for volatile suspended solids during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
Frequency									
673001	15.	10.	4.	5.			33.	15.	82.
683002	15.	12.	4.	5.			25.	45.	106.
683001	15.	10.	6.	14.	23.	11.	55.	72.	206.
413008	16.	11.	4.	3.		12.	37.	26.	109.
413007	16.	10.	4.	8.		4.	30.	43.	115.
413006	15.	10.	6.	16.	33.	29.	69.	92.	270.
413005	16.	32.	4.	85.	37.	27.	73.	97.	371.
413009				3.	21.		44.	25.	93.
413004	16.	11.	6.	3.	2.	2.	37.	49.	126.
413012	29.	13.	12.	6.			2.	6.	68.
413013	30.	12.	12.	6.	6.	2.	2.	8.	78.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.
Mean concentration									
673001	6.07	16.20	9.50	3.40			5.82	14.40	8.73
683002	6.40	14.75	8.50	7.40			9.20	14.62	11.62
683001	8.33	16.40	12.67	12.00	24.88	4.09	17.65	28.31	20.14
413008	5.81	7.82	13.25	7.67		9.42	29.76	24.88	19.41
413007	13.69	7.20	6.25	39.75		95.50	39.17	41.49	34.57
413006	9.00	5.30	7.33	28.75	39.91	21.34	43.78	45.90	36.56
413005	9.56	27.84	21.00	25.56	57.22	18.67	24.38	41.94	31.72
413009				14.00	66.65		64.30	114.84	76.65
413004	8.50	14.27	22.83	12.33	12.50	20.00	23.48	29.67	22.66
413012	7.07	9.15	3.83	18.67			14.00	22.00	9.44
413013	7.63	11.25	3.92	18.50	7.17	9.50	11.00	10.25	8.82
413014	6.77	12.92	4.00	30.17	11.33	17.50	16.00	21.50	11.33
Standard deviation									
673001	4.98	5.49	5.80	3.72			3.71	6.51	4.88
683002	7.00	10.44	3.32	3.72			7.14	8.61	8.04
683001	7.00	6.13	8.80	6.25	28.75	1.70	11.68	25.06	19.07
413008	6.27	5.42	7.89	3.06		4.19	29.52	20.63	20.60
413007	20.59	3.94	5.12	27.48		70.70	62.23	89.46	66.34
413006	12.85	5.64	8.24	19.80	53.07	19.15	107.48	47.68	64.84
413005	8.61	30.36	13.37	18.65	42.87	14.37	21.40	35.41	28.04
413009				3.61	59.06		89.32	156.19	105.91
413004	8.37	8.71	21.51	8.39	2.12	16.97	25.71	26.84	23.10
413012	4.16	3.46	1.27	4.59			1.41	27.07	8.44
413013	5.22	7.01	1.38	4.23	1.33	2.12	.00	3.92	4.72
413014	5.30	6.47	1.86	17.49	4.41	4.95	.00	3.07	6.58

Table I-A-10. Seasonal mean alkalinity (mg/l as $CaCO_3$), standard deviations and frequency of sampling during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.			70.
683002	8.	13.	9.	8.	11.	10.	7.	3.			69.
683001	8.	17.	7.	7.	13.	11.	4.	5.	2.		74.
413008	7.	15.	9.	7.	15.	8	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		1.	70.
413006	8.	14.	7.	7.	13.	8.	5.	1.		2.	65.
413005	7.	16.	9.	11.	16.	9.	5.	3.	2.	2.	80.
413004	7.	15.	7.	8.	13.	9.	5.	5.		1.	70.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	270.67	265.23	307.67	312.22	236.73	235.30	279.33	311.33			271.86
683002	267.37	282.23	306.33	327.62	239.45	231.90	290.57	306.67			276.71
683001	272.50	284.82	300.00	329.14	251.46	246.00	270.00	321.60	192.50		276.68
413008	268.14	267.87	277.56	319.00	231.73	190.25	258.29	201.67			254.04
413007	254.00	198.27	249.33	304.43	247.07	202.80	239.20	230.00		92.00	233.99
413006	231.37	173.14	172.14	192.86	243.15	188.75	186.00	125.00		94.50	196.08
413005	269.57	270.44	274.33	304.45	215.25	226.00	253.80	248.67	160.00	143.50	251.65
413004	258.43	241.73	237.29	282.00	227.69	204.44	223.60	227.80		116.00	236.07
413012	232.67	170.29	167.17	251.67	208.33	131.94	172.50	200.75	170.00		182.46
413013	240.00	172.93	202.00	282.33	227.33	140.83	186.17	252.08	173.33		201.12
413014	250.67	197.33	200.00	280.67	240.95	158.28	178.50	243.17	161.67		208.85
					Standard deviation						
673001	15.09	44.37	11.17	9.68	44.12	41.13	18.10	36.02			32.65
683002	16.37	25.40	6.84	14.48	42.19	28.10	27.27	66.46			28.53
683001	9.49	36.25	4.62	15.36	35.71	20.75	24.39	21.93	10.61		26.78
413008	7.43	30.96	32.39	29.59	36.46	43.10	50.83	2.89			34.39
413007	9.73	29.05	40.87	35.07	1[illegible].25	25.30	32.[illegible]5	.00		.00	27.95
413006	37.77	15.23	23.10	43.60	55.63	37.09	25.42	.00		16.26	37.13
413005	8.79	28.97	20.76	16.91	49.04	25.10	28.81	26.41	14.14	23.34	30.69
413004	10.52	37.39	20.76	12.74	27.97	19.62	17.91	18.66		.00	25.32
413012	1.16	40.14	9.68	9.42	18.49	26.53	43.26	46.18	.00		31.38
413013	6.93	34.76	4.[illegible]3	2.34	23.63	24.27	41.16	24.77	11.55		27.12
413014	5.03	31.88	8.92	5.16	20.09	47.26	40.61	21.40	2.89		31.08

Table I-A-11. Seasonal mean alkalinity (mg/l as $CaCO_3$), standard deviations and frequency of sampling during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	15.	10.	4.	5.			13.	8.	55.
683002	15.	12.	4.	5.			15.	20.	71.
683001	15.	10.	6	10.	18.	1.	24.	21.	105.
413008	16.	11.	4.	3.		1.	16.	11.	62.
413007	16.	10.	4.	4.			12.	17.	63.
413006	15.	11.	6.	7.	24.	2.	36.	35.	136.
413005	16.	33.	4.	70.	31.	12.	49.	32.	247.
413009				3.	4.		30.	17.	54.
413004	16.	11.	6.	3.	2.	2.	13.	17.	70.
413012	29.	13.	13.	6.					61.
413013	30.	12.	12.	6.	6.	2.			68.
413014	30.	12.	12.	6.	6.	2.			68.
				Mean concentration					
673001	218.33	253.40	253.50	232.40			216.00	201.00	225.48
683002	222.07	250.33	227.00	225.20			185.60	170.35	205.06
683001	226.87	231.00	211.33	202.00	192.94	124.00	170.25	155.90	190.08
413008	220.69	225.09	181.75	176.00		128.00	111.25	96.27	164.98
413007	230.19	202.00	195.50	127.00			119.67	78.29	154.92
413006	212.60	147.00	122.83	104.00	104.12	112.00	103.06	80.60	114.15
413005	226.87	164.36	186.50	162.70	146.74	119.75	144.76	116.09	153.78
413009				106.00	79.00		96.83	74.59	89.02
413004	220.81	178.73	168.33	184.67	76.00	70.00	135.69	115.82	158.40
413012	186.73	171.31	217.31	162.67					187.60
413013	197.37	174.17	218.42	153.00	126.67	138.00			185.09
413014	209.20	177.92	219.33	132.83	93.67	110.00			185.62
				Standard deviation					
673001	57.18	39.35	45.65	42.51			35.78	43.69	45.60
683002	54.75	31.27	13.90	14.04			44.56	27.45	38.47
683001	54.08	47.21	21.41	35.31	56.13	.00	45.76	49.69	48.28
413008	52.63	59.14	59.55	24.98		.00	59.66	49.88	55.05
413007	45.80	46.08	40.54	37.74			36.91	28.58	39.26
413006	51.77	59.68	56.85	47.05	38.85	39.60	49.29	34.59	45.47
413005	57.40	65.56	59.20	44.64	46.87	52.66	39.01	37.61	47.90
413009				49.15	44.01		81.88	47.73	69.50
413004	50.37	46.57	52.63	31.77	16.97	.00	41.20	38.45	43.98
413012	53.69	27.96	31.41	3.01					42.42
413013	48.57	28.30	23.24	4.15	8.82	16.97			36.79
413014	48.93	32.66	34.92	38.21	31.81	2.83			41.53

Table I-A-12. Seasonal mean hardness (mg/l as $CaCO_3$), standard deviations and frequency of sampling during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.			70.
683002	8.	13.	9.	8.	11.	10.	7.	3.			69.
683001	9.	16.	7.	7.	13.	11.	4.	5.			72.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		1.	70.
413006	8.	14.	7.	7.	13.	8.	5.	1.		2.	65.
413005	7.	16.	9.	11.	16.	9.	5.	3.		2.	78.
413004	7.	15.	7.	8.	13.	9.	5.	5.		1.	70.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	396.56	350.85	402.78	421.11	341.45	319.20	402.50	415.00			373.61
683002	392.37	371.62	399.44	450.62	344.82	324.70	399.29	430.00			381.09
683001	404.11	384.81	428.57	465.71	364.46	397.73	428.75	465.00			405.65
413008	491.00	428.20	467.22	550.00	404.80	304.62	463.00	411.67			435.21
413007	513.57	434.40	499.44	622.86	500.73	450.50	508.00	485.0		240.00	489.24
413006	424.37	288.00	301.86	370.71	527.00	304.37	288.40	262.00		141.00	360.11
413005	433.14	407.75	426.67	477.27	354.06	383.33	415.80	420.00		234.00	404.72
413004	424.29	367.40	372.86	453.13	373.77	348.44	392.00	395.00		192.00	383.40
413012	290.00	210.79	209.00	337.50	2[illegible]3.57	169.56	225.42	268.50	276.67		238.46
413013	355.00	219.73	259.67	385.00	322.00	183.28	247.17	349.42	280.67		273.86
413014	410.67	271.7[illegible]	279.67	410.83	363.86	226.22	254.08	359.00	304.67		306.61
					Standard deviation						
673001	3[illegible].59	50.03	38.17	12.19	52.58	48.33	31.58	22.91			41.57
683002	32.39	33.93	28.44	21.62	52.62	32.70	35.52	60.83			36.93
683001	36.46	41.67	16.51	9.32	54.10	23.41	21.75	33.17			36.50
413008	84.26	45.96	80.28	52.99	63.13	87.47	153.36	7.64			78.80
413007	31.19	58.81	47.86	55.89	55.96	44.87	38.99	.00		.00	51.11
413006	43.62	53.71	94.53	88.57	130.35	48.65	30.54	.00		38.18	82.07
413005	20.06	38.37	24.49	24.73	78.81	28.08	56.22	27.84		42.43	46.76
413004	22.44	49.25	33.52	17.31	52.08	27.13	41.62	33.73		.00	39.61
413012	5.00	56.56	11.71	17.82	28.43	28.69	62.49	73.38	1.16		45.27
413013	35.00	48.68	3.44	6.32	31.90	27.30	58.51	40.25	6.43		37.83
413014	1.16	46.27	18.39	8.01	30.81	64.24	64.38	33.76	23.01		45.53

Table I-A-13. Seasonal mean hardness (mg/l as $CaCO_3$), standard deviations and frequency of sampling during events and main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	15.	10.	4.	5.			1.	8.	43.
683002	15.	12.	4.	5.			1.	20.	57.
683001	15.	10.	6.	5.	14.	1.	1.	21.	73.
413008	16.	11.	4.	3.		1.	1.	10.	46.
413007	16.	10.	4.	3.			1.	17.	51.
413006	15.	10.	6.	3.	16.	2.	2.	35.	89.
413005	16.	32.	4.	65.	26.	12.	1.	32.	188.
413009				3.			1.	17.	21.
413004	16.	11.	6.	3.	2.	2.	1.	17.	58.
413012	29.	13.	13.	6.					61.
413013	30.	12.	12.	6.	6.	2.			68.
413014	30.	12.	12.	6.	6.	2.			68.
				Mean concentration					
673001	312.40	333.40	346.25	340.80			470.00	288.87	323.02
683002	316.20	330.42	321.50	332.20			440.00	256.10	302.05
683001	351.27	315.60	302.67	286.20	313.86	252.00	470.00	233.67	297.19
413008	405.00	356.18	313.25	314.00		200.00	565.00	161.60	325.52
413007	454.37	371.50	357.00	258.33			520.00	130.88	312.41
413006	385.67	244.00	201.00	192.67	158.87	184.00	393.00	103.23	194.58
413005	404.44	254.69	269.00	253.45	230.88	197.33	475.00	180.87	248.96
413009				198.33			740.00	90.35	136.71
413004	351.44	276.64	253.00	307.33	116.50	101.00	445.00	180.18	259.47
413012	254.34	207.77	288.23	205.33					246.82
413013	282.23	217.75	298.08	252.33	168.50	190.00			258.26
413014	320.03	243.08	335.42	235.00	131.83	157.00			280.26
				Standard deviation					
673001	78.74	46.32	21.36	66.70			.00	62.11	64.15
683002	76.22	39.79	20.87	21.22			.00	55.73	56.16
683001	112.97	63.88	43.01	67.27	95.65	.00	.00	90.52	89.92
413008	130.41	106.70	129. 3	59.09		.00	.00	78.74	111.19
413007	135.65	101.12	98.25	83.03			.00	72.39	104.84
413006	122.98	67.24	107.67	158.97	67.63	31.11	4.24	60.96	82.92
413005	139.97	88.47	95.99	70.70	82.59	103.62	.00	73.79	86.33
413009				69.74			.00	81.93	80.67
413004	121.74	83.76	88.21	65.43	30.41	2.83	.00	70.51	91.69
413012	54.34	36.65	44.94	85.84					52.96
413013	68.79	41.64	40.50	7.42	9.07	25.46			53.23
413014	76.21	50.82	68.63	68.41	42.73	12.73			67.36

Table I-A-14. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total phosphorus during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	FALL77	ALL SEASONS
						Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		4.	2.	76.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	2.	73.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	2.	80.
413008	7.	15.	9.	7.	15.	8.	7.	3.			2.	73.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	2.	78.
413006	6.	14.	7.	7.	13.	9.	5.	1.		9.	10.	83.
413005	7.	16.	9.	11.	17.	9.	5.	3.	2.	13.	14.	106.
413009											1.	1.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	2.	76.
413012	3.	14.	6.	6.	21.	18.	12.	12.	13.			105.
413013	3.	15.	6.	6.	21.	18.	12.	12.	19.			112.
413014	3.	15.	6.	6.	21.	18.	12.	12.	19.			112.
						Mean concentration						
673001	.26	.33	.27	.17	.15	.36	.17	.34		.35	.08	.25
683002	.19	.26	.14	.12	.12	.24	.09	.19		.31	.12	.18
683001	.32	.64	.82	.39	.21	.97	1.00	1.16	.37	.69	.17	.61
413008	.09	.12	.06	.05	.12	.08	.06	.20			.02	.09
413007	.10	.09	.05	.06	.13	.06	.13	.11		.16	.03	.10
413006	.06	.13	.10	.10	.17	.19	.32	.13		.25	.28	.17
413005	.31	.28	.32	.29	.27	.27	.43	.62	.21	.33	.26	.30
413009											.13	.13
413004	.29	.33	.38	.44	.21	.21	.49	.63		.46	.19	.34
413012	.15	.16	.14	.30	.15	.14	.14	.13	.20			.16
413013	.15	.17	.19	.22	.18	.17	.17	.20	.21			.18
413014	.20	.24	.29	.23	.22	.28	.19	.28	.26			.25
						Standard deviation						
673001	.14	.09	.09	.03	.05	.12	.02	.11		.03	.03	.09
683002	.09	.10	.02	.01	.04	.08	.02	.02		.04	.09	.06
683001	.22	.20	.45	.06	.08	.35	.20	.19	.01	.09	.01	.23
413008	.05	.05	.01	.02	.08	.02	.02	.02			.00	.05
413007	.04	.11	.03	.04	.10	.07	.08	.00		.08	.00	.08
413006	.04	.11	.06	.04	.19	.16	.49	.00		.15	.27	.19
413005	.09	.06	.12	.06	.09	.10	.11	.14	.01	.10	.27	.13
413009											.00	.00
413004	.10	.10	.21	.18	.08	.04	.21	.07		.39	.10	.15
413012	.01	.07	.01	.30	.02	.05	.04	.04	.09			.09
413013	.01	.05	.01	.05	.03	.05	.05	.04	.15			.07
413014	.02	.10	.08	.03	.06	.10	.06	.09	.08			.08

Table I-A-15. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total phosphorus during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	FALL77	ALL SEASONS
					Frequency					
673001	15.	10.	4.	5.			33.	29.		96.
683002	15.	12.	4.	5.			25.	65.		126.
683001	15.	10.	6.	14.	23.	11.	55.	91.		225.
413008	16.	11.	4.	3.		12.	37.	40.	1.	124.
413007	16.	10.	4.	8.		4.	30.	57.	1.	130.
413006	15.	10.	6.	15.	33.	29.	69.	119.		296.
413005	16.	32.	4.	85.	37.	27.	73.	161.	3.	438.
413009				3.	21.		4.	38.		106.
413004	16.	11.	6.	3.	2.	2.	32.	68.		140.
413012	29.	13.	12.	6.			2.	6.		68.
413013	30.	12.	12.	6.	6.	2.	2.	8.		78.
413014	30.	12.	12.	6.	6.	2.	2.	8.		78.
					Mean concentration					
673001	.21	.36	.27	.16			.21	.45		.30
683002	.22	.32	.34	.16			.21	.33		.29
683001	.27	.67	.39	.30	.90	.81	.50	.64		.59
413008	.15	.15	.23	.16		.11	.39	.25	.43	.26
413007	.20	.15	.12	.29		1.03	.35	.38	.16	.35
413006	.17	.28	.21	.29	.50	.41	.47	.41		.41
413005	.32	.60	.38	.33	.73	.54	.40	.44	.27	.44
413009				.65	1.06		1.29	1.55		1.32
413004	.28	.40	.37	.27	.24	.48	.43	.37		.37
413012	.24	.22	.19	.28			.30	.46		.25
413013	.24	.28	.20	.26	.16	.22	.23	.23		.23
413014	.25	.28	.25	.30	.20	.27	.32	.37		.27
					Standard deviation					
673001	.10	.08	.06	.10			.14	.30		.19
683002	.12	.13	.20	.05			.11	.08		.10
683001	.11	.33	.17	.11	.25	.05	.18	.22		.20
413008	.12	.08	.09	.08		.02	.30	.22	.00	.22
413007	.33	.06	.04	.09		.81	.43	.62	.00	.50
413006	.17	.20	.18	.18	.59	.43	1.15	.40		.66
413005	.08	1.14	.20	.15	.46	.25	.23	.30	.05	.40
413009				.44	.89		1.09	1.48		1.21
413004	.07	.09	.13	.11	.02	.28	.26	.25		.22
413012	.11	.07	.03	.06			.06	.54		.17
413013	.07	.08	.03	.01	.02	.01	.00	.06		.06
413014	.08	.10	.06	.11	.04	.04	.01	.06		.08

Table I-A-16. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for soluble phosphorus during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		4.	74.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	71.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	76.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	16.	15.	5.	3.	2.	11.	95.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	13.		105.
41301	3.	15.	6.	6.	21.	18.	12.	12.	19.		112.
413014	3.	15.	6.	6.	21.	18.	12.	12.	19.		112.
					Mean concentration						
673001	.14	.12	.14	.10	.07	.10	.03	.14		.18	.11
683002	.10	.13	.09	.07	.07	.15	.02	.12		.18	.10
683001	.20	.45	.66	.26	.12	.73	.79	.92	.20	.41	.45
413008	.04	.05	.02	.01	.05	.01	.01	.20			.04
413007	.02	.03	.02	.01	.03	.00	.01	.02		.02	.02
413006	.03	.09	.05	.03	.04	.09	.22	.06		.05	.07
413005	.20	.16	.21	.18	.14	.12	.26	.44	.10	.14	.17
413004	.19	.19	.23	.15	.10	.08	.20	.27		.11	.16
413012	.05	.06	.07	.11	.06	.03	.04	.06	.06		.06
413013	.03	.07	.11	.13	.06	.04	.04	.11	.07		.07
413014	.06	.10	.15	.12	.08	.05	.04	.13	.08		.09
					Standard deviation						
673001	.09	.09	.04	.02	.05	.09	.02	.08		.00	.07
683002	.06	.08	.02	.00	.03	.05	.01	.02		.00	.05
683001	.15	.25	.41	.07	.06	.33	.16	.17	.00	.09	.23
413008	.04	.04	.01	.00	.05	.00	.00	.25			.06
413007	.03	.03	.01	.00	.02	.00	.01	.00		.01	.02
413006	.04	.09	.04	.01	.04	.12	.40	.00		.07	.12
413005	.08	.06	.09	.04	.05	.04	.09	.10	.00	.03	.06
413004	.09	.05	.11	.06	.07	.03	.09	.07		.03	.07
413012	.01	.04	.01	.01	.03	.02	.01	.02	.02		.02
413013	.02	.04	.02	.01	.04	.02	.01	.03	.02		.03
413014	.06	.03	.03	.02	.07	.02	.02	.02	.02		.04

Table I-A-17. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for soluble phosphorus during events at main stem river stations

Frequency

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
673001	15.	10.	4.	5.			33.	28.	95.
683002	15.	12.	4.	5.			25.	63.	124.
683001	15.	10.	6.	10.	23.	11.	55.	89.	223.
413008	16.	11.	4.	3.		12.	37.	38.	121.
413007	16.	10.	4.	3.		4.	30.	55.	122.
413006	15.	10.	6.	11.	33.	28.	69.	115.	287.
413005	16.	32.	4.	81.	37.	27.	73.	126.	396.
413009				3.	21.		44.	38.	106.
413004	16.	11.	6.	3.	2.	2.	32.	67.	139.
413012	29.	13.	12.	6.			2.	6.	68.
413013	30.	12.	12.	6.	6.	2.	2.	9.	79.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.

Mean concentration

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
673001	.11	.14	.16	.09			.09	.22	.14
683002	.10	.14	.12	.09			.09	.15	.12
683001	.14	.37	.22	.14	.53	.61	.19	.27	.28
413008	.05	.05	.05	.06		.01	.07	.02	.05
413007	.04	.06	.04	.07		.00	.07	.04	.04
413006	.06	.12	.08	.06	.07	.13	.05	.04	.05
413005	.15	.14	.13	.10	.08	.15	.10	.07	.09
413009				.34	.14		.31	.33	.29
413004	.13	.17	.12	.10	.08	.15	.10	.07	.09
413012	.09	.09	.10	.11			.02	.03	.09
413013	.09	.10	.10	.04	.01	.01	.02	.02	.07
413014	.12	.08	.11	.12	.01	.01	.10	.02	.09

Standard deviation

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
673001	.06	.10	.03	.07			.11	.16	.12
683002	.05	.05	.03	.03			.07	.06	.06
683001	.06	.27	.08	.06	.19	.06	.13	.14	.14
413008	.06	.05	.03	.05		.00	.11	.01	.07
413007	.03	.04	.01	.05		.00	.18	.02	.09
413006	.06	.09	.06	.04	.15	.32	.07	.04	.12
413005	.05	.06	.03	.04	.09	.08	.09	.04	.06
413009				.17	.13		.17	.21	.16
413004	.04	.07	.02	.04	.01	.08	.09	.04	.06
413012	.04	.05	.02	.03			.00	.01	.04
413013	.03	.06	.02	.02	.00	.00	.00	.01	.03
413014	.05	.05	.02	.04	.01	.00	.00	.01	.04

Table I-A-18. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for organic nitrogen during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		3.	73.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	71.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	8.	7.	15.	10.	5.	1.		7.	75.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	17.	9.	5.	3.	2.	11.	90.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	1.14	1.61	1.00	.79	1.10	1.76	1.40	1.63		1.67	1.30
683002	.97	1.11	1.18	.75	.97	.80	.79	.90		1.15	.96
683001	1.03	1.22	.93	.69	.88	1.28	1.57	1.14	1.15	1.20	1.09
413008	.76	.70	.69	.60	.93	.92	.67	1.73			.81
413007	.90	.77	.40	.61	1.14	.49	.73	.60		.79	.76
413006	.51	.45	.36	.38	.64	.61	.60	.60		1.29	.63
413005	1.06	.88	.82	.52	1.00	1.17	1.06	.93	.95	1.36	.97
413004	.76	.98	1.19	2.11	.86	.95	.92	.80		1.44	1.09
413012	.78	.64	.46	.56	.88	.60	1.16	.51	1.07		.74
413013	.81	.59	.55	.67	.93	.67	.71	.58	1.03		.72
413014	.61	.76	.67	.63	.99	.98	.81	.71	1.10		.85
					Standard deviation						
673001	.43	.57	.22	.14	.30	.43	.27	.21		.23	.37
683002	.30	.37	1.48	.09	.21	.12	.25	.10		.21	.58
683001	.39	.34	.13	.39	.25	.55	.48	.78	.21	.20	.40
413008	.14	.17	.23	.23	.21	.58	.14	.15			.26
413007	.37	.77	.07	.29	.55	.26	.36	.00		.27	.48
413006	.12	.24	.13	.18	.27	.47	.43	.00		.56	.33
413005	.26	.21	.31	.22	.28	.34	.33	.06	.07	.38	.28
413004	.29	.18	.68	2.35	.16	.45	.20	.30		1.12	.88
413012	.08	.24	.08	.06	.25	.18	1.69	.18	.06		.63
413013	.21	.21	.05	.03	.22	.17	.14	.14	.12		.18
413014	.14	.32	.18	.18	.24	.28	.23	.14	.10		.24

Table I-A-19. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for organic nitrogen during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	15.	10.	4.	5.			33.	28.	95.
683002	15.	12.	4.	5.			25.	63.	124.
683001	14.	10.	6.	14.	23.	11.	55.	90.	223.
413008	16.	11.	4.	3.		12.	37.	38.	121.
413007	16.	10.	4.	8.		4.	30.	55.	127.
413006	15.	10.	6.	16.	33.	29.	69.	115.	293.
413005	16.	32.	4.	85.	37.	27.	73.	127.	401.
413009				3.	21.		4.	38.	106.
413004	16.	11.	6.	3.	2.	2.	32.	67.	139.
413012	29.	13.	13.	6.			2.	6.	69.
413013	30.	12.	12.	6.	6.	2.	2.	8.	78.
413014	30.	12.	12.	5.	6.	2.	2.	8.	77.
				Mean concentration					
673001	1.16	1.48	1.06	.92			1.65	1.97	1.59
683002	.94	1.16	.99	.91			1.48	1.31	1.25
683001	1.03	1.72	2.54	1.03	1.68	.87	1.66	1.74	1.58
413008	.91	.77	1.11	.91		.61	1.72	.99	1.15
413007	1.27	.66	.61	.88		3.82	1.83	1.77	1.60
413006	.67	.80	.59	.93	2.09	1.32	2.39	1.90	1.80
413005	.99	1.09	1.11	1.19	2.63	1.70	1.61	1.83	1.62
413009				1.39	3.53		3.87	5.49	4.31
413004	.96	1.02	1.24	1.31	.75	1.47	1.76	1.35	1.36
413012	.91	.74	.82	1.08			1.60	1.95	.99
413013	.97	.86	.82	1.19	.95	1.45	1.70	1.52	1.03
413014	1.01	1.30	.90	1.33	1.29	2.10	2.25	2.50	1.29
				Standard deviation					
673001	.62	.41	.15	.04			.26	1.31	.79
683002	.39	.48	.09	.07			.34	.26	.32
683001	.38	.29	3.90	.25	.70	.08	.43	.53	.76
413008	.28	.33	.26	.14		.12	.59	.45	.45
413007	1.80	.22	.09	.43		2.70	1.68	2.56	2.06
413006	.43	.39	.25	.51	2.31	.83	5.57	1.46	2.99
413005	.33	.45	.30	.41	1.84	.77	.62	1.05	.91
413009				.66	3.21		3.90	6.25	4.75
413004	.33	.38	.45	.63	.10	1.03	.78	.84	.74
413012	.36	.28	.17	.14			.14	1.32	.47
413013	.33	.29	.14	.57	.27	.21	.00	.30	.31
413014	.59	.78	.16	.25	.48	.28	.07	.72	.57

Table I-A-20. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for ammonia nitrogen during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	6.	3.		4.	74.
683002	8.	13.	9.	7.	11.	10.	7.	3.		2.	70.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	76.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	17.	15.	5.	3.		11.	96.
413004	7.	15.	7.	8.	13.	9.	5.	5.	2.	5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	.19	.22	.55	.80	.31	.23	.30	2.00		1.05	.46
683002	.09	.11	.14	.43	.15	.09	.35	1.18		.54	.23
683001	.21	.17	.85	2.33	.47	.48	3.22	10.64	1.70	1.47	1.44
413008	.12	.12	.15	.28	.22	.11	.05	.95			.19
413007	.10	.08	.14	.20	.16	.07	.25	.36		.11	.13
413006	.08	.19	.17	.20	.17	.15	.11	.24		.09	.15
413005	.18	.07	.32	1.78	.49	.06	.93	4.23	.90	.17	.58
413004	.12	.11	.50	1.26	.34	.25	.70	2.26		.31	.53
413012	.25	.49	.80	.56	.32	.48	.69	.80	.54		.53
413013	.32	.56	.75	.63	.39	.55	.56	1.09	.55		.60
413014	.50	.64	.80	.79	.47	.83	.57	1.30	.87		.74
					Standard deviation						
673001	.09	.11	.20	.27	.35	.14	.37	.56		.10	.24
683002	.06	.05	.07	.15	.08	.04	.38	.85		.03	.21
683001	.13	.11	.21	.83	.78	.45	2.12	2.30	.28	.42	.85
413008	.07	.03	.06	.08	.14	.03	.05	.05			.08
413007	.07	.04	.04	.11	.08	.04	.14	.00		.07	.07
413006	.04	.31	.20	.05	.11	.19	.07	.00		.02	.18
413005	.11	.05	.21	.63	.44	.04	.81	.64	.00	.12	.36
413004	.05	.06	.23	.44	.39	.11	.67	.32		.39	.32
413012	.02	.10	.01	.08	.21	.11	.19	.12	.01		.14
413013	.28	.11	.07	.07	.27	.20	.14	.32	.11		.21
413014	.26	.25	.09	.07	.39	.76	.15	.40	.05		.43

Table I-A-21. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for ammonia nitrogen during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	15.	10.	4.	5.			33.	28.	95.
683002	15.	12.	4.	5.			25.	63.	124.
683001	15.	10.	6.	14.	23.	11.	55.	90.	224.
413008	16.	11.	4.	3.		12.	36.	38.	120.
413007	16.	10.	4.	8.		4.	30.	55.	127.
413006	15.	10.	6.	15.	33.	29.	69.	115.	292.
413005	16.	32.	4.	87.	37.	27.	73.	127.	403.
413009				3.	21.		44.	38.	106.
413004	16.	11.	6.	3.	2.	2.	32.	67.	139.
413012	29.	13.	13.	6.			2.	6.	69.
413013	30.	12.	12.	6.	6.	2.	2.	8.	78.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.
				Mean concentration					
673001	.25	.25	.47	.40			.56	.54	.46
683002	.19	.18	.18	.23			.23	.11	.16
683001	.22	.32	.33	.32	.48	2.61	1.02	.27	.60
413008	.21	.22	.22	.40		.02	.32	.09	.20
413007	.17	.12	.18	.20		.14	.18	.09	.14
413006	.16	.20	.23	.24	.13	.07	.15	.11	.13
413005	.31	.15	.26	.37	.14	.10	.61	.13	.28
413009				.71	.58		1.51	.83	1.05
413004	.26	.24	.45	.43	.22	.22	.36	.15	.23
413012	.39	.46	.40	.43			.12	.23	.39
413013	.41	.48	.39	.49	.35	.34	.10	.22	.39
413014	.45	.34	.50	1.54	.33	.15	.60	.03	.47
				Standard deviation					
673001	.13	.19	.29	.11			.41	.59	.42
683002	.10	.11	.03	.04			.21	.08	.12
683001	.14	.25	.06	.18	.45	.50	.93	.26	.53
413008	.19	.13	.10	.37		.02	.23	.17	.19
413007	.07	.07	.08	.11		.10	.20	.13	.14
413006	.09	.16	.25	.09	.09	.08	.21	.12	.14
413005	.15	.12	.13	.21	.13	.12	.53	.16	.27
413009				.35	.32		.81	.61	.66
413004	.14	.20	.15	.16	.03	.03	.52	.15	.29
413012	.12	.21	.12	.25			.00	.08	.15
413013	.12	.25	.06	.55	.17	.13	.01	.10	.20
413014	.18	.30	.13	2.51	.20	.00	.01	.02	.70

Table I-A-22. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for nitrate plus nitrite nitrogen during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	8.	10.	8.	7.	8.	7.	3.	2.		4.	57.
683002											
683001	7.	9.	8.	4.	8.	6.	5.	2.		2.	51.
413008	8.	13.	6.	5.	9.	8.	3.	4.	2.	3.	61.
413007	6.	12.	6.	5.	10.	5.	5.				49.
413006	6.	11.	8.	5.	12.	7.	3.			7.	59.
413005	7.	11.	5.	5.	10.	6.	3.			9.	56.
413004	6.	13.	7.	7.	14.	11.	3.	2.	2.	11.	76.
413012	6.	11.	5.	6.	10.	6.	3.	4.		5.	56.
413013	3.	14.	6.	6.	21.	9.	9.	6.	3.		77.
413014	3.	15.	6.	6.	21.	9.	9.	6.	3.		78.
					Mean concentration						
673001	1.20	.54	1.14	2.31	1.90	.28	1.99	2.50		1.00	1.27
683002											
683001	1.33	1.59	2.49	2.62	1.67	3.25	3.17	1.51		1.75	2.04
413008	1.40	.62	.35	2.00	3.20	.18	.08	.00	.00	.00	1.25
413007	.26	.05	.24	.52	1.86	.05	.18				.54
413006	.34	.13	.09	.71	1.48	.20	.23			.96	.59
413005	1.03	.97	1.21	1.83	1.72	.47	1.43			1.22	1.20
413004	.87	.52	.74	1.59	1.89	.42	.93	.51	.00	.97	.99
413012	.91	.24	.24	1.58	1.02	.26	.67	1.21		.00	.74
413013	1.17	.23	.19	1.84	1.20	.21	.66	1.52	1.12		.83
413014	1.33	.24	.18	1.72	1.32	.17	.66	1.32	1.03		.83
					Standard deviation						
673001	.41	.46	.36	.37	.50	.21	1.26	.57		.05	.47
683002											
683001	.31	.81	.23	.36	.69	1.13	.31	.16		.13	.63
413008	.72	.30	.49	.71	1.25	.22	.16	.00	.00	.00	.64
413007	.21	.04	.20	.11	1.59	.04	.11				.74
413006	.28	.08	.09	.16	.72	.23	.14			.24	.37
413005	.32	.25	.64	.24	.60	.25	.50			.14	.39
413004	.42	.38	.53	.22	.59	.30	.34	.04	.00	.08	.40
413012	.01	.07	.04	.07	.51	.11	.32	.18		.00	.24
413013	.09	.08	.06	.04	.65	.08	.36	.14	.08		.38
413014	.11	.16	.04	.09	.61	.14	.30	.20	.02		.36

Table I-A-23. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling or nitrate plus nitrite nitrogen during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency					
673001	14.	9.	4.	5.			32.	28.	92.
683002	15.	10.	4.	5.			24.	63.	121.
683001	14.	9.	6.	14.	23.	11.	54.	90.	221.
413008	15.	10.	4.	3.		12.	36.	38.	118.
413007	15.	9.	4.	8.		4.	29.	55.	124.
413006	14.	9.	6.	16.	33.	29.	68.	115.	290.
413005	15.	31.	4.	87.	37.	27.	72.	126.	399.
413009				3.	21.		44.	38.	106.
413004	16.	9.	5.	3.	2.	2.	31.	67.	135.
413012	29.	13.	13.	6.			2.	6.	69.
413013	30.	12.	12.	6.	6.	2.	2.	8.	78.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.
				Mean concentration					
673001	1.84	.97	2.17	2.17			3.61	.62	2.03
683002	1.39	.82	1.50	1.78			2.59	.86	1.33
683001	1.48	1.57	1.97	1.50	2.26	2.70	2.09	1.53	1.81
413008	2.30	1.00	2.84	2.33		.32	1.86	.42	1.26
413007	1.05	.33	.67	.89		.51	1.07	.56	.74
413006	1.21	.51	.71	.95	.47	.34	1.06	.68	.75
413005	1.50	.92	1.58	1.41	.55	1.19	1.58	.78	1.12
413009				1.42	.68		1.17	.32	.78
413004	1.28	.82	1.22	1.64	.60	.66	1.72	.78	1.09
413012	.75	.37	1.30	1.68			1.31	.22	.83
413013	.87	.35	1.20	1.67	.23	.23	1.38	.18	.78
413014	1.02	.31	1.51	1.49	.34	.58	2.30	.35	.92
				Standard deviation					
673001	.88	.77	1.25	.23			1.55	.47	1.08
683002	.70	.49	.84	.12			1.27	.47	.73
683001	.46	.49	.48	.30	1.23	.44	.73	.55	.67
413008	1.13	1.03	2.44	.15		.20	1.41	.22	1.03
413007	.65	.20	.28	.41		.13	.56	.29	.43
413006	.55	.31	.58	.48	.36	.32	.60	.38	.45
413005	.59	.28	.89	.41	.28	.39	.72	.35	.46
413009				.38	.46		.43	.24	.38
413004	.75	.31	.44	.35	.16	.06	.96	.46	.64
413012	.46	.24	.65	.17			.01	.26	.44
413013	.61	.21	.64	.21	.06	.13	.00	.30	.49
413014	.76	.35	1.02	.31	.14	.15	.00	.36	.67

Table I-A-24. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total carbon during non-events at main stem river stations

Storet Number	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency					
673001	7.	9.	9.	11.	10.	6.	3.			55.
683002	7.	9.	8.	11.	10.	7.	3.			55.
683001	12.	7.	7.	13.	11.	4.	5.			59.
413008	8.	9.	7.	15.	8.	7.	3.			57.
413007	10.	9.	7.	15.	10.	5.	1.		1.	58.
413006	9.	7.	7.	13.	9.	5.	1.		2.	53.
413005	11.	9.	11.	16.	9.	5.	3.		2.	66.
413004	9.	7.	8.	13.	9.	5.	5.		1.	57.
413012	12.	6.	6.	21.	18.	12.	12.	3.		90.
413013	12.	6.	6.	21.	18.	12.	12.	3.		90.
413014	12.	6.	6.	21.	18.	12.	12.	3.		90.
					Mean concentration					
673001	17.43	10.39	10.72	13.59	11.40	10.25	8.17			12.03
683002	14.79	9.56	11.56	13.05	6.55	9.64	5.50			10.45
683001	10.75	10.79	11.07	11.04	9.09	9.62	12.50			10.62
413008	9.38	9.33	10.64	12.17	7.40	9.29	19.33			10.49
413007	4.50	6.50	11.71	18.57	5.40	8.90	6.00		11.50	10.00
413006	4.00	11.14	5.93	10.35	6.00	8.10	9.00		23.25	8.30
413005	9.59	8.50	10.09	12.75	7.61	8.10	8.00		15.00	10.00
413004	10.22	8.27	12.25	10.62	5.33	9.40	8.00		14.00	9.36
413012	7.52	6.42	9.25	11.17	4.58	5.42	7.29	10.50		7.61
413013	7.75	9.25	10.83	11.07	5.19	6.67	9.50	10.33		8.49
413014	7.96	9.00	9.17	11.10	6.86	5.71	7.71	10.33		8.37
					Standard deviation					
673001	8.37	3.21	1.44	2.35	3.23	3.93	2.75			3.98
683002	7.35	2.79	1.18	1.37	2.07	3.28	1.32			3.30
683001	6.18	2.02	1.74	1.86	2.80	3.43	10.23			4.46
413008	4.90	2.28	2.39	1.82	2.32	1.66	1.89			2.65
413007	2.93	2.79	3.17	14.21	2.98	4.79	.00		.00	6.00
413006	1.95	17.61	1.83	2.74	5.49	2.90	.00		.35	7.11
413005	3.83	2.38	.80	1.90	3.18	3.11	2.78		.71	2.59
413004	2.53	2.56	4.09	1.45	1.70	4.60	4.03		.00	2.88
413012	2.29	2.48	1.61	2.68	1.73	1.56	3.11	.87		2.29
413013	3.83	2.73	3.50	2.36	1.53	1.48	4.82	.76		2.90
413014	2.19	3.56	.68	2.34	2.85	1.23	2.43	.76		2.34

Table I-A-25. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for total carbon during events at main stem river stations

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
				Frequency				
673001	4.	4.	5.			9.	8.	30.
683002	5.	4.	5.			6.	21.	41.
683001	3.	6.	10.	22.	11.	16.	24.	92.
413008	5.	4.	3.		5.	13.	10.	40.
413007	3.	4.	4.		3.	13.	19.	46.
413006	3.	6.	6.	33.	20.	26.	36.	130.
413005	25.	4.	70.	35.	23.	29.	33.	219.
413009			3.	21.		25.	16.	65.
413004	4.	6.	3.	2.	2.	11.	17.	45.
413012	4.	12.	6.					22.
413013	3.	12.	6.	6.	2.		2.	31.
413014	3.	12.	6.	6.	2.		2.	31.
				Mean concentration				
673001	12.00	13.12	13.00			16.67	16.75	14.99
683002	12.10	11.62	12.70			17.58	14.76	13.90
683001	9.50	13.58	11.45	13.73	6.65	16.59	17.75	14.03
413008	8.80	12.62	11.17		7.20	20.04	16.00	14.61
413007	9.00	9.50	14.12		44.00	26.27	17.21	20.04
413006	12.17	8.92	12.08	22.00	26.07	25.13	26.44	23.20
413005	12.53	12.62	13.69	21.51	1 .85	22.13	21.62	17.12
413009			14.50	28.76		50.90	52.62	42.49
413004	9.25	12.58	13.33	6.50	11.50	25.05	15.65	15.43
413012	12.90	7.62	13.25					10.12
413013	9.00	7.83	13.75	4.42	7.25		14.00	8.79
413014	9.90	8.37	16.42	6.08	10.75		22.50	10.70
				Standard deviation				
673001	4.02	2.06	1.17			3.08	3.84	3.14
683002	3.59	1.84	.67			7.40	5.22	4.95
683001	2.29	2.75	2.44	8.13	.99	2.55	12.55	7.83
413008	2.36	4.77	2.47		1.04	5.76	7.09	5.31
413007	4.27	2.20	4.31		24.25	12.19	6.99	9.93
413006	7.23	6.01	2.31	22.73	16.22	11.33	14.63	16.27
413005	5.48	3.30	4.72	13.27	5.36	9.11	10.19	8.29
413009			4.92	26.05		41.30	35.60	34.73
413004	1.94	3.20	3.33	1.41	5.66	14.55	4.72	8.26
413012	9.54	2.72	1.92					4.43
413013	1.32	2.55	2.36	1.07	.35		.00	2.09
413014	3.73	3.17	7.35	1.74	2.47		2.12	4.17

Table I-A-26. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for chlorides during non-events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	WIN 76	SPR 76	SUM 76	FALL76	WIN 77	SPR 77	SUM 77	ALL SEASONS
					Frequency						
673001	9.	13.	9.	9.	11.	10.	5.	3.		4.	73.
683002	8.	13.	9.	8.	11.	10.	7.	3.		2.	71.
683001	9.	17.	7.	7.	13.	11.	4.	5.	2.	3.	78.
413008	7.	15.	9.	7.	15.	8.	7.	3.			71.
413007	7.	15.	9.	7.	15.	10.	5.	1.		7.	76.
413006	8.	14.	7.	7.	13.	9.	5.	1.		9.	73.
413005	7.	16.	9.	11.	17.	9.	5.	3.	2.	11.	90.
413004	7.	15.	7.	8.	13.	9.	5.	5.		5.	74.
413012	3.	14.	6.	6.	21.	18.	12.	12.	3.		95.
413013	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
413014	3.	15.	6.	6.	21.	18.	12.	12.	3.		96.
					Mean concentration						
673001	55.67	67.62	74.22	75.56	49.55	116.50	139.00	145.00		83.25	80.84
683002	52.87	60.50	71.89	73.25	56.82	101.00	129.29	163.33		120.00	80.96
683001	96.33	107.71	160.00	184.29	112.46	222.73	252.50	357.00	431.50	173.33	169.21
413008	73.00	71.33	69.78	161.86	121.87	74.12	193.57	1003.33			142.65
413007	171.86	135.87	173.33	1120.00	486.67	143.50	181.00	450.00		116.43	309.82
413006	238.75	132.36	102.43	1403.57	570.00	116.44	300.00	1250.00		102.00	362.07
413005	126.00	119.50	140.33	400.45	179.94	162.22	263.00	530.00	587.50	122.91	204.59
413004	123.14	102.80	114.00	381.87	248.23	118.67	177.00	337.40		100.80	184.16
413012	32.00	30.86	40.83	142.00	49.57	26.06	55.33	129.25	160.00		61.37
413013	77.67	36.00	55.67	190.83	85.43	34.33	62.75	192.33	166.67		85.68
413014	121.67	58.87	71.50	247.50	118.10	54.28	89.83	238.25	311.67		119.70
					Standard deviation						
673001	8.54	14.81	21.88	5.66	13.66	29.26	14.32	39.05		4.72	18.03
683002	8.81	8.92	6.77	3.50	13.90	20.66	20.09	15.27		.00	13.08
683001	24.56	31.25	36.51	32.07	90.98	68.17	38.62	58.05	79.90	37.86	55.26
413008	12.33	25.98	16.14	77.39	133.77	24.03	247.15	40.41			103.33
413007	27.22	20.49	42.89	1133.06	615.66	23.34	42.49	.00		61.42	441.66
413006	35.73	38.11	65.43	1109.74	517.42	54.30	406.56	.00		61.03	421.49
413005	29.05	26.34	24.89	217.34	147.90	17.70	151.23	180.83	229.81	24.19	115.15
413004	7.47	21.59	13.30	158.11	441.16	29.53	86.86	192.74		19.92	204.03
413012	.00	10.36	2.40	6.93	25.74	8.45	21.53	83.37	.00		33.70
413013	24.01	10.70	2.73	9.70	48.57	6.71	19.14	70.30	63.51		36.78
413014	6.51	16.46	5.32	17.25	54.69	16.96	56.68	79.57	37.53		45.24

Table I-A-27. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for chlorides during events at main stem river stations

Storet Number	SPR 75	SUM 75	FALL75	SPR 76	SUM 76	FALL76	SPR 77	SUM 77	ALL SEASONS
Frequency									
673001	15.	10.	4.	5.			33.	16.	83.
683002	15.	12.	4.	5.			25.	48.	109.
683001	15.	10.	6.	14.	23.	1.	55.	72.	196.
413008	16.	11.	4.	3.		4.	37.	26.	101.
413007	16.	10.	4.	8.			30.	43.	111.
413006	15.	10.	6.	16.	33.	18.	69.	93.	260.
413005	16.	32.	4.	85.	37.	22.	72.	102.	370.
413009				3.	21.		44.	25.	93.
413004	16.	11.	6.	3.	2.	2.	35.	49.	124.
413012	9.	13.	13.	6.			2.	6.	69.
413013	30.	12.	12.	6.	6.	2.	2.	8.	76.
413014	30.	12.	12.	6.	6.	2.	2.	8.	78.
Mean concentration									
673001	43.40	64.40	65.50	59.20			79.03	103.16	73.63
683002	52.93	54.21	59.75	113.00			98.92	67.29	72.95
683001	79.20	93.90	83.50	101.43	172.39	130.00	172.67	126.81	136.58
413008	84.25	61.91	68.00	231.67		53.75	280.27	51.81	147.80
413007	208.25	121.20	237.75	161.00			489.73	70.95	220.95
413006	342.53	110.40	156.17	131.19	45.21	64.44	276.94	59.05	140.51
413005	126.50	76.66	105.75	163.53	88.27	110.23	275.87	74.22	140.33
413009				156.67	22.19		171.91	17.68	96.15
413004	112.50	81.45	131.33	276.67	45.00	35.00	193.40	66.33	116.88
413012	56.55	66.23	63.38	138.33			97.50	34.33	66.03
413013	78.82	36.42	87.42	255.00	35.17	49.00	130.00	45.75	80.97
413014	115.50	60.42	93.42	173.33	32.67	41.00	110.00	48.37	92.77
Standard deviation									
673001	13.45	19.16	17.25	7.79			19.76	40.72	24.00
683002	12.70	22.35	8.18	12.55			35.87	24.56	25.66
683001	22.78	38.00	14.42	33.29	71.78	.00	70.10	66.22	62.13
413008	39.46	13.39	28.39	112.51		17.52	311.67	26.10	194.82
413007	183.04	36.58	187.10	137.36			869.94	44.01	465.78
413006	430.03	38.15	161.60	189.42	37.06	23.93	298.44	49.15	195.21
413005	46.50	30.78	65.43	94.86	40.46	47.53	175.36	33.36	94.50
413009				70.24	29.98		241.68	28.24	169.55
413004	33.45	33.92	104.76	125.03	15.56	1.41	108.40	28.92	69.13
413012	37.32	96.85	22.04	34.88			31.82	5.46	51.12
413013	42.80	6.07	58.54	12.25	5.74	1.41	.00	5.47	36.32
413014	88.31	14.52	26.73	15.05	5.61	1.41	.00	16.56	58.50

Table I-A-28. Seasonal mean concentrations (μg/l), standard deviations and frequency of sampling for lead, cadmium, copper and zinc during non-events at main stem river stations.

Lead

Storet Number	SPR 76	SUM 77	ALL SEASONS
Frequency			
413006		1.	1.
413005	3.	1.	4.
Mean concentration			
413006		1.50	1.50
413005	24.33	1.50	18.62
Standard deviation			
413006		.00	.00
413005	16.17	.00	16.17

Cadmium

Storet Number	SPR 76	SUM 77	ALL SEASONS
Frequency			
413006		1.	1.
413005	3.	1.	4.
Mean concentration			
413006		.10	.10
413005	.20	1.70	.57
Standard deviation			
413006		.00	.00
413005	.17	.00	.17

Copper

Storet Number	SPR 76	SUM 77	ALL SEASONS
Frequency			
413006		1.	1.
413005	3.	1.	4.
Mean concentration			
413006		1.50	1.50
413005	14.33	1.50	11.12
Standard deviation			
413006		.00	.00
413005	5.86	.00	5.86

Zinc

Storet Number	SPR 76	SUM 77	ALL SEASONS
Frequency			
413006		1.	1.
413005	3.	1.	4.
Mean concentration			
413006		60.00	60.00
413005	27.67	120.00	50.75
Standard deviation			
413006		.00	.00
413005	6.81	.00	6.81

Table I-A-29. Seasonal mean concentrations (μg/l), standard deviations and frequency of sampling for lead and cadimium during events at main stem river stations.

	Lead						
Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	2.					7.	9.
683002	2.					7.	9.
683001	2.			4.		10.	16.
413008	2.					3.	5.
413007	2.		5.			9.	16.
413006	2.		5.	4.		15.	26.
413005	8.	14.	6.			12.	40.
413004	2.				1.	10.	13.
413012	2.					6.	8.
413013	2.					6.	8.
413014	2.					6.	8.
			Mean concentration				
673001	1.50					10.71	8.67
683002	1.50					11.43	9.22
683001	4.25			8.75		18.50	14.28
413008	3.75					12.00	8.70
413007	24.50		130.90			494.22	321.97
413006	35.00		150.20	223.75		436.93	318.08
413005	266.12	55.07	73.50			98.04	112.94
413004	16.00				700.00	36.00	84.00
413012	29.00					64.67	55.75
413013	63.50					18.83	30.00
413014	66.50					44.67	50.12
			Standard deviation				
673001	.00					8.34	7.72
683002	.00					8.54	7.91
683001	3.89			.96		12.20	10.21
413008	3.18					7.81	6.64
413007	4.95		211.25			1315.69	1038.75
413006	.00		103.42	181.97		782.30	629.22
413005	210.39	40.55	72.45			112.99	117.60
413004	8.49				.00	52.38	49.76
413012	7.07					110.55	100.96
413013	47.38					7.86	20.63
413014	75.66					15.38	33.93

	Cadmium						
Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	1.					7.	8.
683002	1.					7.	8.
683001	1.			4.		10.	15.
413008	1.					3.	4.
413007	1.		5.			9.	15.
413006	1.		5.	4.		15.	25.
413005	7.	14.	5.			12.	38.
413004	1.				1.	10.	12.
413012	1.					6.	7.
413013	1.					6.	7.
413014	1.					6.	7.
			Mean concentration				
673001	.10					1.18	1.04
683002	.10					.75	.66
683001	.10			.85		.91	.84
413008	.10					.33	.27
413007	.10		1.06			2.91	2.11
413006	.30		1.50	5.10		2.26	2.48
413005	1.60	1.09	2.04			1.33	1.39
413004	.30				10.20	1.48	2.11
413012	.10					1.37	1.19
413013	.10					.63	.55
413014	.10					3.42	2.94
			Standard deviation				
673001	.00					1.35	1.35
683002	.00					.69	.69
683001	.00			.13		1.09	.95
413008	.00					.21	.21
413007	.00		.39			5.23	4.28
413006	.00		1.11	3.45		4.91	4.24
413005	.50	.46	2.54			1.21	1.21
413004	.00				.00	.86	.86
413012	.00					1.88	1.88
413013	.00					.19	.19
413014	.00					1.86	1.86

Table I-A-30. Seasonal mean concentrations (µg/l) standard deviations and frequency of sampling for copper and zinc during events at main stem river stations.

Storet Number	Copper SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS	Storet Number	Zinc SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
Frequency								Frequency							
673001	2.					7.	9.	673001	2.					7.	9.
683002	2.					7.	9.	683002	2.					7.	9.
683001	2.			4.		10.	16.	683001	2.			4.		10.	16.
413008	2.					3.	5.	413008	2.					3.	5.
413007	2.		5.			9.	16.	413007	2.		5.			9.	16.
413006	2.		5.	4.		15.	26.	413006	2.		5.	4.		15.	26.
413005	8.	14.	6.			12.	40.	413005	8.	14.	6.			12.	40.
413004	2.				1.	10.	13.	413004	2.				1.	10.	13.
413012	2.					6.	8.	413012	2.					6.	8.
413013	2.					6.	8.	413013	2.					6.	8.
413014	2.					6.	8.	413014	2.					6.	8.
Mean concentration								Mean concentration							
673001	10.00					60.00	48.89	673001	1.50					230.71	179.78
683002	10.00					82.86	66.67	683002	2.25					98.00	76.72
683001	35.00			60.00		110.00	88.12	683001	6.2			44.00		32.10	31.84
413008	10.00					53.33	36.00	413008	3.25					33.00	21.10
413007	80.00		134.00			316.67	230.00	413007	14.00		45.80			149.33	100.06
413006	130.00		164.00	415.00		439.33	358.85	413006	13.50		32.60	73.25		89.03	69.94
413005	170.00	79.29	91.67			169.17	126.25	413005	59.87	57.21	25.00			41.58	48.22
413004	65.00				440.00	155.00	163.08	413004	11.50				154.00	41.75	45.73
413012	10.00					130.00	100.00	413012	3.25					42.50	32.69
413013	15.00					81.67	65.00	413013	4.25					30.67	24.06
413014	20.00					138.33	108.75	413014	2.75					45.00	34.44
Standard deviation								Standard deviation							
673001	.00					41.63	38.54	673001	.00					329.92	305.44
683002	.00					74.10	68.60	683002	1.06					71.27	65.98
683001	7.07			11.55		55.78	46.78	683001	6.72			17.09		15.37	15.31
413008	.00					5.77	4.71	413008	2.47					4.58	4.01
413007	42.43		92.36			625.72	493.66	413007	7.07		35.56			368.54	289.79
413006	.00		87.35	316.49		680.86	556.81	413006	6.36		13.96	76.79		184.07	149.68
413005	115.02	27.86	77.57			66.18	77.18	413005	37.19	21.44	11.80			17.62	23.43
413004	21.21				.00	86.95	82.77	413004	2.12				.00	45.22	42.90
413012	.00					133.12	121.52	413012	2.47					25.11	22.94
413013	7.07					22.29	20.55	413013	3.89					10.95	10.12
413014	14.14					27.14	25.44	413014	1.77					26.65	24.34

Table I-A-31. Seasonal mean concentrations (μg/l), standard deviations and frequency of sampling for chromium, nickel, iron and aluminum during non-events at main stem river stations.

Chromium

Storet Number	SPR 76	SUM 77	ALL SEASONS
	Frequency		
413006		1.	1.
413005	3.	1.	4.
	Mean concentration		
413006		23.00	23.00
413005	7.00	5.00	6.50
	Standard deviation		
413006		.00	.00
413005	1.73	.00	1.73

Nickel

Storet Number	SPR 76	SUM 77	ALL SEASONS
	Frequency		
413006		1.	1.
413005	2.	1.	3.
	Mean concentration		
413006		40.00	40.00
413005	10.00	32.00	17.33
	Standard deviation		
413006		.00	.00
413005	.00	.00	.00

Iron

Storet Number	SPR 76	SUM 77	ALL SEASONS
	Frequency		
413006		1.	1.
413005	3.	1.	4.
	Mean concentration		
413006		2.50	2.50
413005	1.73	1.20	1.59
	Standard deviation		
413006		.00	.00
413005	.77	.00	.77

Aluminum

Storet Number	SPR 76	SUM 77	ALL SEASONS
	Frequency		
413006		1.	1.
413005	2.	1.	3.
	Mean concentration		
413006		2900.00	2900.00
413005	92.00	1000.00	394.67
	Standard deviation		
413006		.00	.00
413005	31.11	.00	31.11

Table I-A-32. Seasonal mean concentrations (µg/l), standard deviations and frequency of sampling for chromium and nickel during events at main stem river stations.

Chromium

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	2.					7.	9.
683002	2.					7.	9.
683001	2.			4.		10.	16.
413008	2.					3.	5.
413007	2.		5.			9.	16.
413006	2.		5.	4.		15.	26.
413005	8.	14.	6.			12.	40.
413004	2.				1.	10.	13.
413012	2.					6.	8.
413013	2.					6.	8.
413014	2.					6.	8.
			Mean concentration				
673001	1.50					5.79	4.83
683002	1.50					7.86	6.44
683001	1.50			5.87		11.70	8.97
413008	1.50					3.33	2.60
413007	5.20		12.70			77.11	47.99
413006	9.06		8.80	63.50		86.43	62.02
413005	23.15	11.93	15.25			33.67	21.19
413004	5.80				77.00	29.05	29.16
413012	2.25					99.00	74.81
413013	2.25					24.33	18.81
413014	2.25					37.83	28.94
			Standard deviation				
673001	.00					7.37	6.82
683002	.00					7.1	6.66
683001	.00			2.96		8.45	7.17
413008	.00					.58	.47
413007	2.55		14.49			207.05	162.62
413006	2.83		3.63	77.84		193.14	156.74
413005	14.19	9.96	13.15			27.89	15.35
413004	1.70				.00	29.15	27.66
413012	1.06					196.71	179.57
413013	1.06					22.69	20.71
413014	1.06					14.39	13.14

Nickel

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	2.					7.	9.
683002	2.					7.	9.
683001	2.			4.		10.	16.
413008	2.					3.	5.
413007	2.					9.	11.
413006	2.			4.		15.	21.
413005	8.	14.	2.			12.	36.
413004	2.				1.	10.	13.
413012	2.					6.	8.
413013	2.					6.	8.
413014	2.					6.	8.
			Mean concentration				
673001	10.00					10.00	10.00
683002	10.00					11.43	11.11
683001	21.00			10.00		25.80	21.25
413008	10.00					10.00	10.00
413007	10.00					27.33	24.18
413006	10.00			10.00		1 .73	14.10
413005	33.12	10.00	10.00			25.50	20.31
413004	10.00				10.00	19.40	17.23
413012	10.00					13.33	12.50
413013	10.00					17.67	15.75
413014	10.00					12.00	11.50
			Standard deviation				
673001	.00					.00	.00
683002	.00					3.78	3.50
683001	15.56			.00		12.77	11.47
413008	.00					.00	.00
413007	.00					23.32	21.99
413006	.00			.00		11.18	9.86
413005	45.28	.00	.00			19.63	24.11
413004	.00				.00	17.96	17.04
413012	.00					8.16	7.45
413013	.00					20.76	18.95
413014	.00					4.90	4.47

Table I-A-33. Seasonal mean consentrations (µg/l), standard deviations and frequency of sampling for iron and aluminum during events at main stem river stations.

Iron

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	2.					7.	9.
683002	2.					7.	9.
683001	2.			4.		10.	16.
413008	2.					3.	5.
413007	2.		5.			9.	16.
413006	2.		5.	4.		15.	26.
413005	8.	14.	6.			12.	40.
413004	2.				1.	10.	13.
413012	2.					6.	8.
413013	2.					6.	8.
413014	2.					6.	8.
			Mean concentration				
673001	1.16					1.54	1.46
683002	1.51					3.20	2.82
683001	3.55			5.02		5.99	5.44
413008	2.85					2.77	2.80
413007	4.29		9.64			13.00	10.86
413006	3.70		9.00	9.22		11.64	10.15
413005	11.76	3.16	6.54			7.29	6.63
413004	3.14				14.00	6.23	6.35
413012	1.32					4.63	3.80
413013	1.42					2.23	2.13
413014	1.39					3.90	3.27
			Standard deviation				
673001	.51					1.22	1.14
683002	.01					2.87	2.65
683001	.92			2.59		6.12	5.25
413008	.50					.76	.69
413007	3.61		5.70			28.97	22.97
413006	2.83		6.27	4.48		13.98	11.60
413005	8.82	1.24	5.50			4.56	5.12
413004	2.35				.00	3.85	3.73
413012	.68					6.60	6.03
413013	.96					1.67	1.58
413014	1.00					2.04	1.91

Aluminum

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SPR 77	SUM 77	ALL SEASONS
			Frequency				
673001	2.					7.	9.
683002	2.					7.	9.
683001	2.			4.		10.	16.
413008	2.					3.	5.
413007	2.					9.	11.
413006	2.			4.		15.	21.
413005	8.	14.	2.			12.	36.
413004	2.				1.	10.	13.
413012	2.					6.	8.
413013	2.					6.	8.
413014	2.					6.	8.
			Mean concentration				
673001	521.00					1551.43	1322.44
683002	370.50					3357.14	2693.44
683001	830.00			1420.00		5750.00	4052.50
413008	1065.00					2400.00	1866.00
413007	769.00					6228.89	5236.18
413006	854.00			1215.00		6989.33	5305.14
413005	2860.00	987.86	210.00			6106.67	3066.94
413004	660.00				4800.00	5224.00	4489.23
413012	202.00					2700.00	2075.50
413013	290.00					2083.33	1635.00
413014	262.00					3300.00	2540.50
			Standard deviation				
673001	270.12					1538.08	1427.64
683002	403.76					3327.09	3084.06
683001	42.43			648.90		6854.72	5712.00
413008	219.20					608.28	512.53
413007	114.55					11321.45	10674.04
413006	121.62			439.20		5828.28	5143.27
413005	3000.04	322.26	104.65			4080.90	2781.38
413004	311.13				.00	3911.58	3712.15
413012	59.40					2871.93	2621.82
413013	48.08					1843.28	1682.79
413014	65.05					2589.21	2363.76

Table I-A-34. Seasonal concentrations (µg/l), standard deviations and frequency of sampling for mercury during non-events and events at main stem river stations

Non-Event

Storet Number	SUM 75	SPR 76	ALL SEASONS
	Frequency		
413008	1.		1.
413005		3.	3.
	Mean concentration		
413008	.00		.00
413005		.10	.10
	Standard deviation		
413008	.00		.00
413005		.00	.00

Event

Storet Number	SUM 75	FALL75	SPR 76	SUM 76	SUM 77	ALL SEASONS
			Frequency			
673001	2.				3.	5.
683002	2.				2.	4.
683001	2.				3.	5.
413008	2.					2.
413007	2.		5.		4.	11.
413006	2		5.		6.	13.
413005	2.	14.	6.	7.	2.	31.
413009					1.	1.
413004	2.				3.	5.
413012	2.					2.
413013	2.					2.
413014	2.					2.
			Mean concentration			
673001	.10				.15	.13
683002	.10				.10	.10
683001	.10				.19	.16
413008	.30					.30
413007	.25		.10		.34	.21
413006	.15		.10		.19	.15
413005	.10	.11	.12	.19	.10	.13
413009					.10	.10
413004	.50				.10	.26
413012	.15					.15
413013	.25					.25
413014	.10					.10
			Standard deviation			
673001	.00				.09	.07
683002	.00				.00	.00
683001	.00				.16	.13
413008	.14					.14
413007	.21		.00		.28	.19
413006	.07		.00		.14	.10
413005	.00	.04	.06	.11	.00	.07
413009					.00	.00
413004	.57				.00	.33
413012	.07					.07
413013	.21					.21
413014	.00					.00

Table I-A-35. Seasonal mean concentrations (mg/1), standard deviations and frequency of sampling for calcium and magnesium during non-events at main stem river stations

	Calcium				Magnesium		
Storet Number	SUM 75	SPR 76	ALL SEASONS	Storet Number	SUM 75	SPR 76	ALL SEASONS
	Frequency				Frequency		
673001	1.		1.	673001	1.		1.
683002	1.		1.	683002	1.		1.
683001	1.		1.	683001	1.		1.
413008	1.		1.	413008	1.		1.
413007	1.		1.	413007	1.		1.
413006	1.		1.	413006	1.		1.
413005	1.	2.	3.	413005	1.	2.	3.
413004	1.		1.	413004	1.		1.
	Mean concentration				Mean concentration		
673001	90.00		90.00	673001	40.00		40.00
683002	98.00		98.00	683002	43.00		43.00
683001	100.00		100.00	683001	45.00		45.00
413008	118.00		118.00	413008	50.00		50.00
413007	90.00		90.00	413007	43.00		43.00
413006	60.00		60.00	413006	25.00		25.00
413005	99.00	51.50	67.33	413005	43.00	20.00	27.67
413004	94.00		94.00	413004	40.00		40.00
	Standard deviation				Standard deviation		
673001	.00		.00	673001	.00		.00
683002	.00		.00	683002	.00		.00
683001	.00		.00	683001	.00		.00
413008	.00		.00	413008	.00		.00
413007	.00		.00	413007	.00		.00
413006	.00		.00	413006	.00		.00
413005	.00	.71	.71	413005	.00	2.83	2.83
413004	.00		.00	413004	.00		.00

Table I-A-36. Seasonal mean concentrations (mg/l), standard deviations and frequency of sampling for calcuim and magnesium during events at main stem river stations.

Storet Number	Calcium SUM 75	Calcium FALL75	Calcium SPR 76	Calcium SUM 76	ALL SEASONS
	Frequency				
673001	2.				2.
683002	2.				2.
683001	2.				2.
413008	2.				2.
413007	2.				2.
413006	3.				3.
413005	3.	14.	11.	7.	35.
413004	2.				2.
413012	1.				1.
413013	1.				1.
413014	1.				1.
	Mean concentration				
673001	35.05				35.05
683002	38.55				38.55
683001	37.05				37.05
413008	42.05				42.05
413007	44.55				44.55
413006	43.03				43.03
413005	46.73	72.21	53.18	59.71	61.55
413004	29.05				29.05
413012	.10				.10
413013	.10				.10
413014	.10				.10
	Standard deviation				
673001	49.43				49.43
683002	54.38				54.38
683001	52.26				52.26
413008	59.33				59.33
413007	62.86				62.86
413006	37.18				37.18
413005	40.30	25.70	4.12	10.64	20.23
413004	40.94				40.94
413012	.00				.00
413013	.00				.00
413014	.00				.00

Storet Number	Magnesium SUM 75	Magnesium FALL75	Magnesium SPR 76	Magnesium SUM 76	ALL SEASONS
	Frequency				
673001	1.				1.
683002	1.				1.
683001	1.				1.
413008	1.				1.
413007	1.				1.
413006	2.				2.
413005	2.	14.	11.	7.	34.
413004	1.				1.
	Mean concentration				
673001	36.00				36.00
683002	36.00				36.00
683001	35.00				35.00
413008	39.00				39.00
413007	39.00				39.00
413006	27.00				27.00
413005	31.00	23.87	19.73	26.57	23.51
413004	27.00				27.00
	Standard deviation				
673001	.00				.00
683002	.00				.00
683001	.00				.00
413008	.00				.00
413007	.00				.00
413006	.00				.00
413005	.00	4.88	2.94	6.48	4.65
413004	.00				.00

Table I-A-37. Bacteria counts in non-event samples obtained at the main stem river stations

Date/type of bacteria	Bacteria counts* (X100) at station:								
	673001	683002	683001	413008	413007	413006	413005	413009	413004
750609									
Fecal coliform	0.3	1.2	4.0	3.7	1.9	2.9	3.2	1,900	47
761004									
Total coliform	16	19		8.0	14	150	21	57	250
Fecal coliform		2.8		0.4	1.8	11	1.9	12	29
Fecal streptococcus	0.4	3.9		0.4	1.7	8.0	0.6	2.2	18
771019									
Total coliform	18	9.2	24	12	8.4	57	250	1,000	
Fecal coliform	3.0	0.9	1.2	3.3	0.9	6.0	2.3	100	
Fecal streptococcus	0.7	0.4	0.6	2.7	1.0	3.5	2.0	100	

*Total coliforms are expressed as MFCC/100 ml, fecal coliforms correspond to MFFCC/100 ml and fecal streptococci are in counts/100 ml. MFCC is membrane filtered coliform counts and MFFCC is membrane filtered fecal coliform counts.

Table I-A-38. Bacteria counts in runoff event samples obtained at the main stem river stations

STORET number	Date	Time	Bacteria counts* (X100) Total coliform	Fecal coliform	Fecal streptococcus
673001	750617	0945		14	
683002	750617	0920		8.7	
683001	750617	1120		14	
413008	750617	1100		11	
413007	750617	1725		270	
413006	750617			370	
413005	750617	1745		520	
413009	750617	1815		3,000	
413004	750617	1845		510	
673001	750624	1020	9	1.4	3.1
683002	750624	955	660	84	59
683001	750624	1140	630	72	300
413008	750624	1120	450	140	300
413007	750624	1320	440	200	400
413006	750624	1400	3,000	500	200
413005	750624	1420	4,000	400	200
413009	750624	1500	6,000	630	300
413004	750624	1540	6,400	530	1,600
673001	750903	0930	12	1.0	0.7
683002	750903	0900	1,500	120	30
683001	750903	1045	170	5.0	9
413008	750903	1025	170	27	29
413007	750903	1205	660	46	46
413006	750903	1245	6,100	240	19
413005	750903	1255	960	48	29
413009	750903	1330	270,000	17,000	6,000
413004	750903	1400	5,100	310	180
413005	760728	0725	1,100	500	1,000
	760728	0805	500	220	180
	760728	0830	300	230	180
	760728	0900	200	270	180
	760728	0930	300	300	210
	760728	1700	500	440	190
413005	770912	1310	500	110	150
	770912	1340	840	780	640
	770912	1410	440	260	340
	770912	1540	410	220	300
	770913	1000	510	120	95
413006	770912	1255	180	200	300
	770912	1320	1,300	770	650
	770912	1355	1,300	240	680
	770912	1515	600	190	290
	770913	1015	520	140	88

*Total coliforms are expressed as MFCC/100 ml; fecal coliforms correspond to MFFCC/100 ml and fecal streptococcus are in counts/100 ml. MFCC is membrane filtered coliform counts and MFFCC is membrane filtered fecal coliform counts.

Table I-A-39. Comparison of mean concentration of selected parameters in the Menomonee River and other rivers in southeastern Wisconsin with water quality criteria

Source of concentration value	Concentration, mg/L*										
	NH_3-N	NO_3+NO_2-N	Cu	Pb	Zn	Cd	Dissolved oxygen	Suspended solids	Total P	Fecal coliform	Cl
Drinking water criteria**		10	1	0.050		0.010				200††	250
Freshwater aquatic life**	1.6		0.047+++	4.82+++	0.082+++	0.012	5	80	0.05†		
Menomonee River (413005) event***	0.33 (0.46)++	1.15 (0.58)	0.048 (0.025)	0.112 (0.138)	0.126 (0.086)	0.001 (0.001)		178 (204)	0.45 (0.42)	23,276	184 (313)
Menomonee River (413005) baseflow***	0.58 (0.92)	1.20 (0.57)	0.011 (0.008)	0.018 (0.017)	0.050 (0.046)	0.001 (0.001)	12.2	49 (70)	0.30 (0.14)	423	204 (164)
Menomonee River (413006) event***	0.15 (0.20)	0.78 (0.53)	0.069 (0.143)	0.32 (0.61)	0.36 (0.54)	0.002 (0.004)		205 (288)	0.42 (0.67)	305,000	166 (313)
Menomonee River (413006) baseflow***	0.15 (0.17)	0.59 (0.61)	0.001	0.001	0.06		11	201 (288)	0.17 (0.19)		362 (562)
Muckwonago River baseflow+	0.07	0.09					8		0.04	33	10
Oconomowoc River baseflow+	0.05	0.09					9		0.02	72	12

*Fecal coliforms are expressed as MFFCC/100 ml. MFFCC is membrane filtered coliform counts.
**Values are U.S. water quality criteria (11,12) unless otherwise specified.
***Average of all measured concentration values for 1975, 1976 and 1977.
+These rivers in southeastern Wisconsin are of good water quality.
++Standard deviation.
+++Criteria for fathead minnows under hard water conditions.
†Values for total P represent concentration that could limit the growth of noxious plants in streams and lakes
††Coliform limit for bathing waters.

Table I-A-40. Correlation coefficients (r) for selected water quality parameter concentrations during the spring and summer of 1977 at the main stem river stations

Parameter	Spring 1977				Summer 1977			
	Total P	Soluble P	Chloride	Suspended solids	Total P	Soluble P	Chloride	Suspended solids
STORET No. 673001								
Total P	1.000				1.000			
Soluble P	0.942**	1.000			0.806**	1.000		
Chloride	0.750**	0.679**	1.000		0.907**	0.846**	1.000	
Suspended solids	0.180	0.028	0.101	1.000	0.892**	0.504**	0.209	1.000
Flow	-0.647**	-0.624**	-0.732**	-0.234*	0.101	0.101	-0.770**	0.020
n+	31	31	31	79	26	26	16	53
STORET No. 683002								
Total P	1.000				1.000			
Soluble P	0.124	1.000			0.280*	1.000		
Chloride	-0.015	-0.884**	1.000		0.125	0.711**	1.000	
Suspended solids	0.795**	0.071	-0.145	1.000	0.590**	-0.499**	-0.535**	1.000
Flow	0.096	0.616*	-0.740**	0.251	0.439**	-0.104	-0.237	0.641**
n	13	13	13	33	52	52	38	86
STORET No. 683001								
Total P	1.000				1.000			
Soluble P	0.491**	1.000			0.156	1.000		
Chloride	0.180	0.485**	1.000		-0.146	0.764**	1.000	
Suspended solids	0.493**	-0.377**	-0.393**	1.000	0.659**	-0.501**	-0.589**	1.000
Flow	0.090	-0.402**	-0.591**	0.500**	0.447**	-0.450**	-0.587**	0.456**
n	55	55	55	171	84	83	67	168
STORET No. 413008								
Total P	1.000				1.000			
Soluble P	0.404*	1.000			0.595**	1.000		
Chloride	-0.515**	-0.633**	1.000		-0.557**	-0.198	1.000	
Suspended solids	0.786**	0.349	-0.611**	1.000	0.973**	0.386*	-0.603**	1.000
Flow	0.617**	0.511	-0.762**	0.661**	0.599**	0.717	-0.421**	0.529**
n	23	23	23	78	35	35	24	79
STORET No. 413007								
Total P	1.000				1.000			
Soluble P	0.257	1.000			-0.133	1.000		
Chloride	-0.117	-0.006	1.000		-0.145	-0.500**	1.000	
Suspended solids	0.918*	-0.135	-0.104	1.000	0.986**	-0.167	-0.156	1.000
Flow	0.360	0.040	-0.259	0.439**	0.114	0.146	-0.463**	0.187
n	23	23	23	61	57	57	45	102
STORET No. 413006								
Total P	1.000				1.000			
Soluble P	0.084	1.000			0.066	1.000		
Chloride	-0.044	0.066	1.000		-0.070	0.007	1.000	
Suspended solids	0.990**	0.043	-0.057	1.000	0.868**	-0.020	-0.291	1.000
Flow	0.146	0.165	0.212	0.261**	0.317**	0.004	-0.518**	0.664**
n	67	67	67	193	113	113	92	278
STORET No. 413005								
Total P	1.000				1.000			
Soluble P	0.149	1.000			0.115	1.000		
Chloride	-0.489**	-0.008	1.000		-0.271**	0.451**	1.000	
Suspended solids	0.819**	-0.294	-0.431**	1.000	0.789**	-0.354**	-0.589**	1.000
Flow	0.498**	-0.410**	-0.526**	0.758*	0.492**	-0.305**	-0.617**	0.710*
n	65	65	65	120	127	126	105	247
STORET No. 413009								
Total P	1.000				1.000			
Soluble P	0.127	1.000			0.770*	1.000		
Chloride	-0.216	0.000	1.000		0.030	0.077	1.000	
Suspended solids	0.766**	-0.357	-0.211	1.000	0.532**	0.183	-0.138	1.000
Flow	0.321	-0.415*	-0.373	0.606**	0.167	-0.045	0.321	0.309
n	27	27	27	75	24	24	20	29

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*Significant at P = 0.05.

**Significant at P = 0.01

+Number of event concentrations of parameters available for correlation analysis in each season.

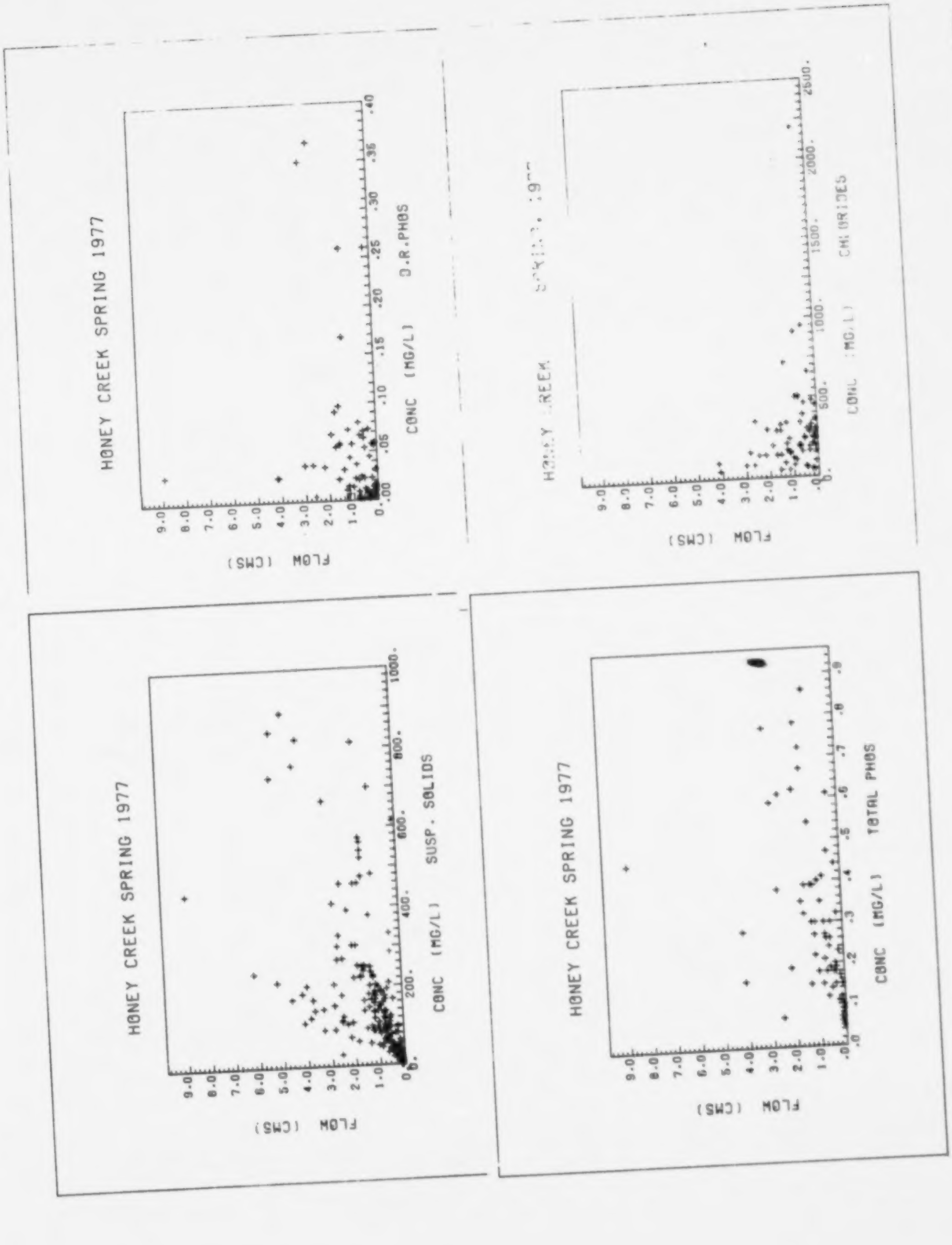


Fig. I-A-1. Relationships of event flow and parameter concentrations at Honey Creek (413006) during spring 1977.

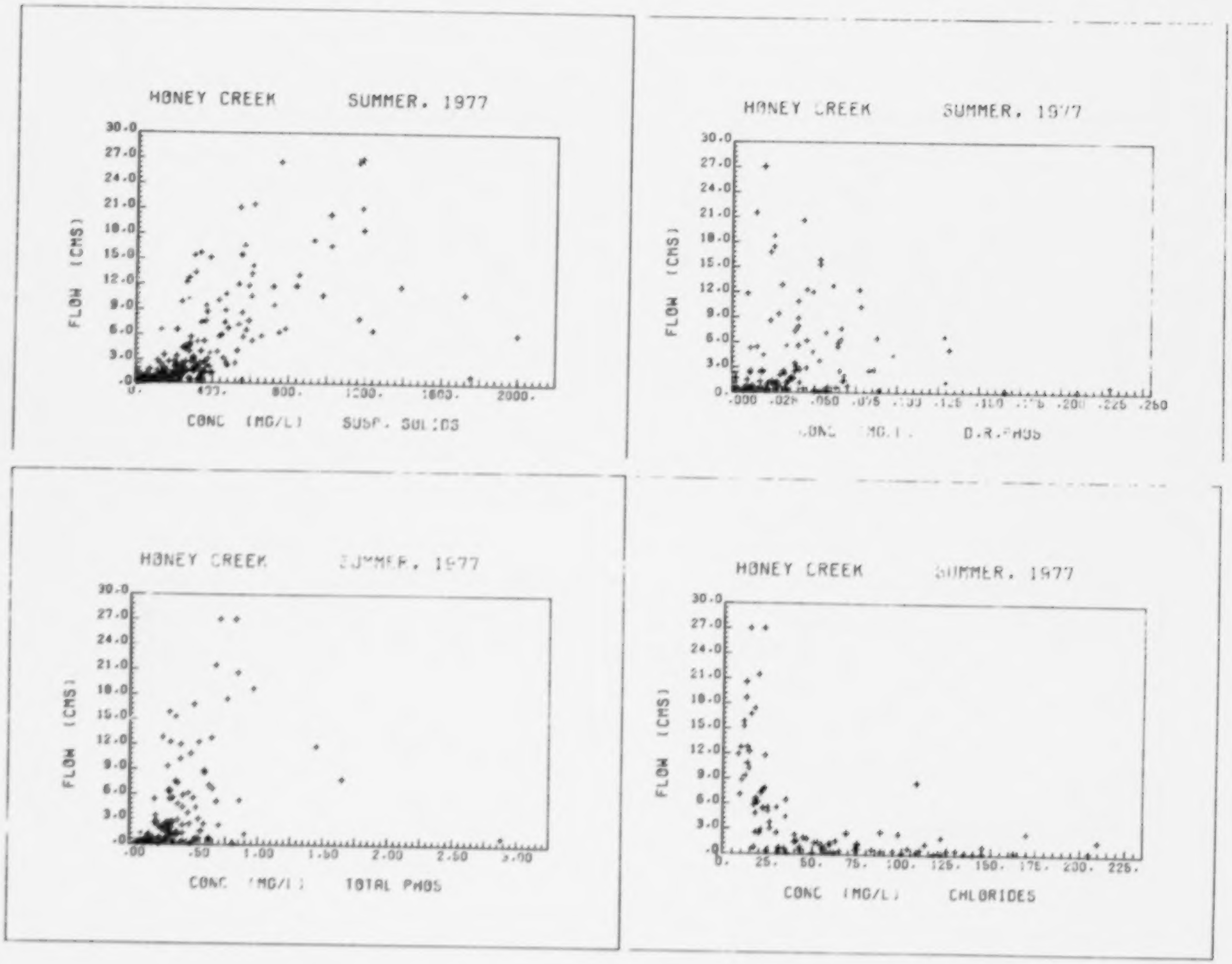


Fig. I-A-2. Relationships of event flow and parameter concentrations at Honey Creek (413006) during summer 1977.

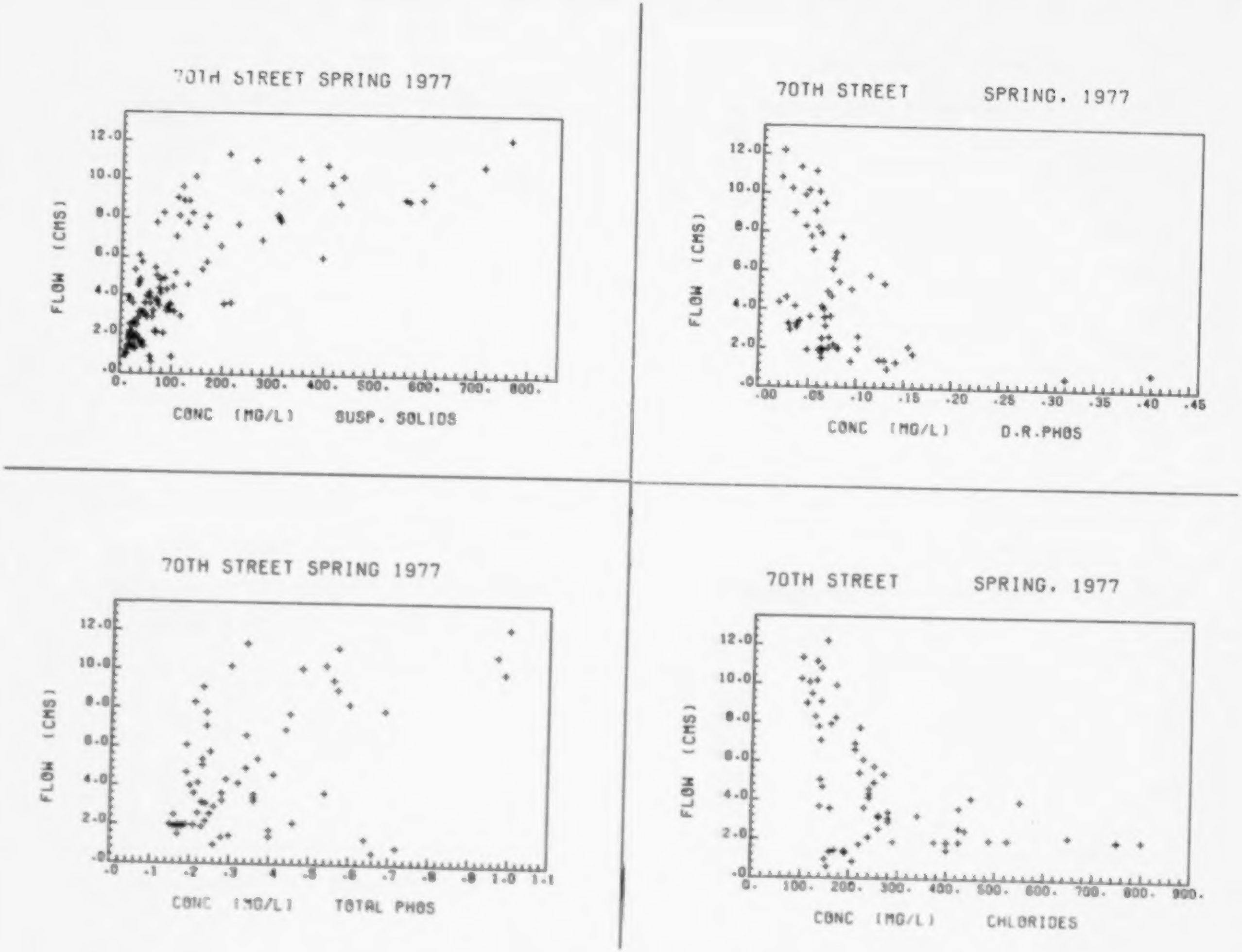


Fig. I-A-3. Relationships of event flow and parameter concentrations at 70th St. (413005) during spring 1977.

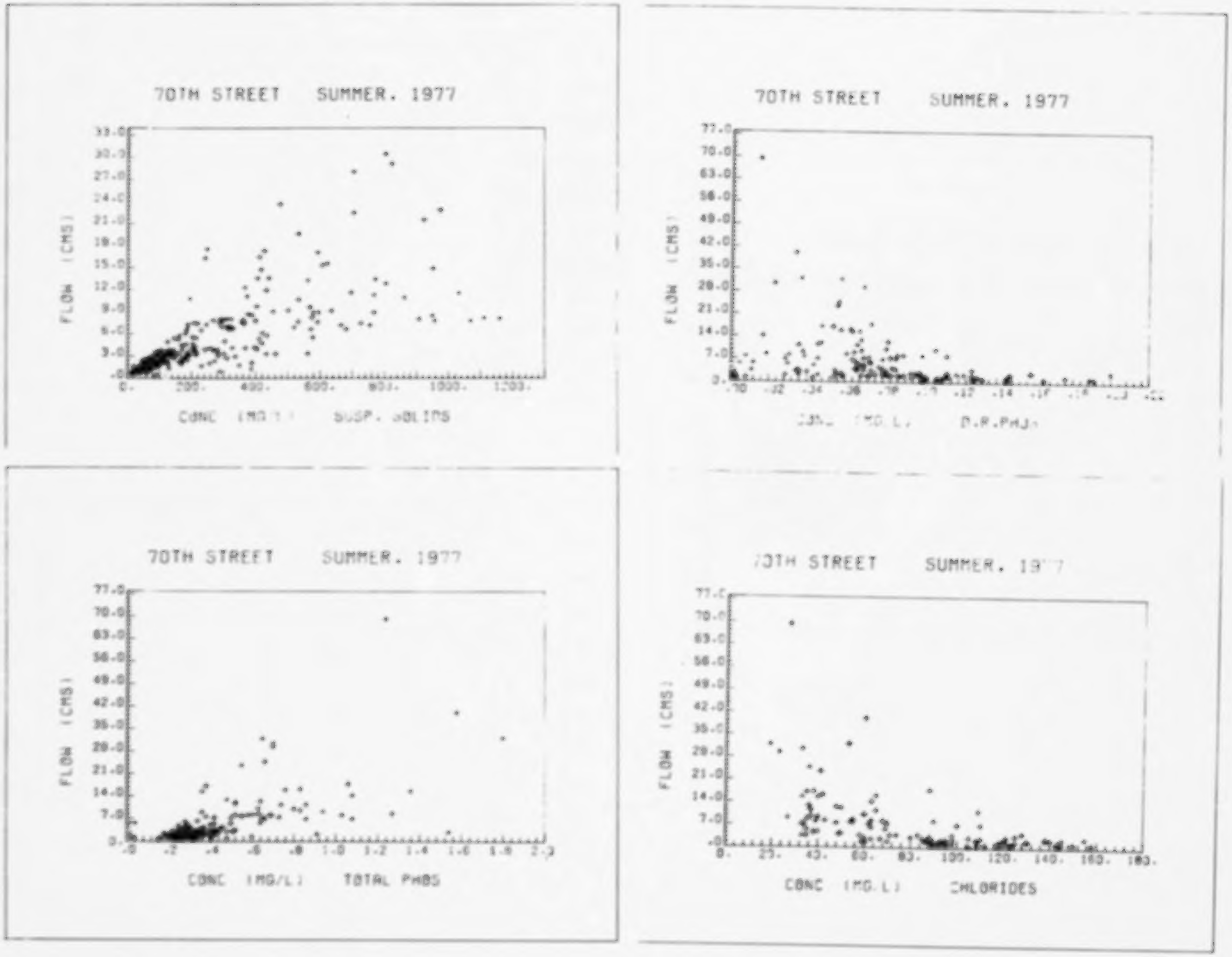


Fig. I-A-4. Relationships of event flow and parameter concentrations at 70th St. (413005) during summer 1977.

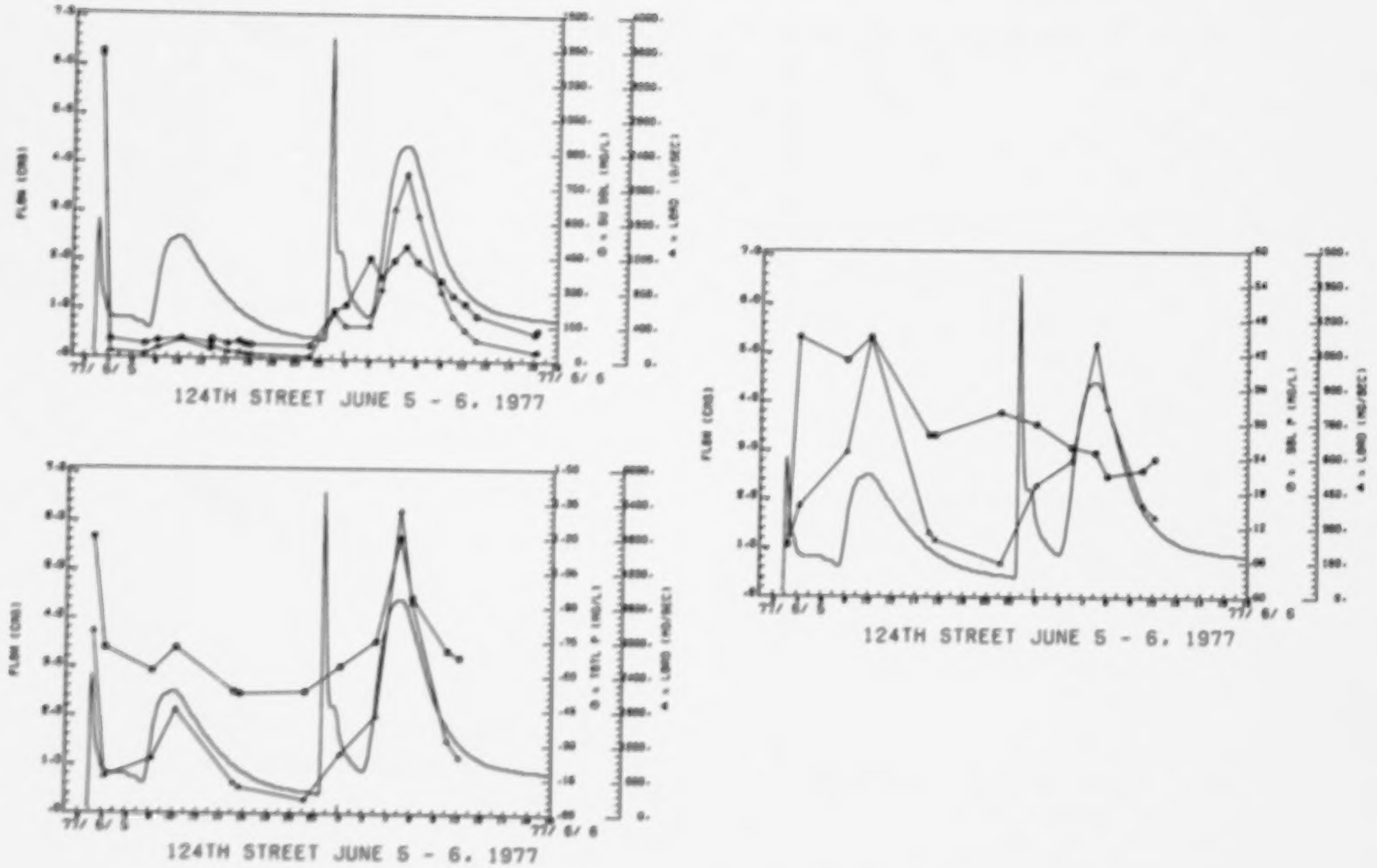


Fig. I-A-5. Flow and parameter concentrations and loading rates for event on June 5-6, 1977 at 124th St. (683001).

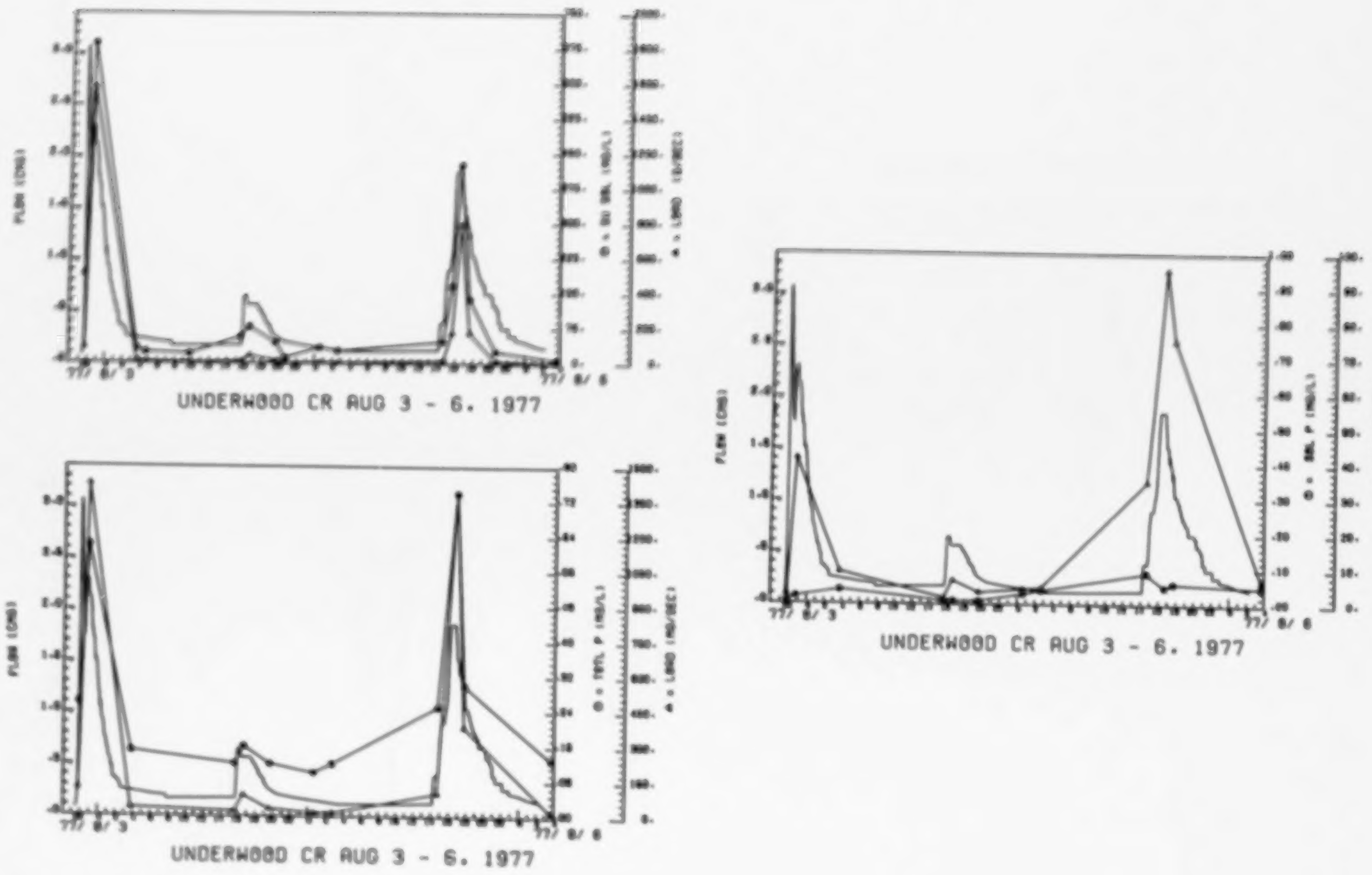


Fig. I-A-6. Flow and parameter concentrations and loading rates for event on July 17-18, 1977 at Underwood Creek (413007).

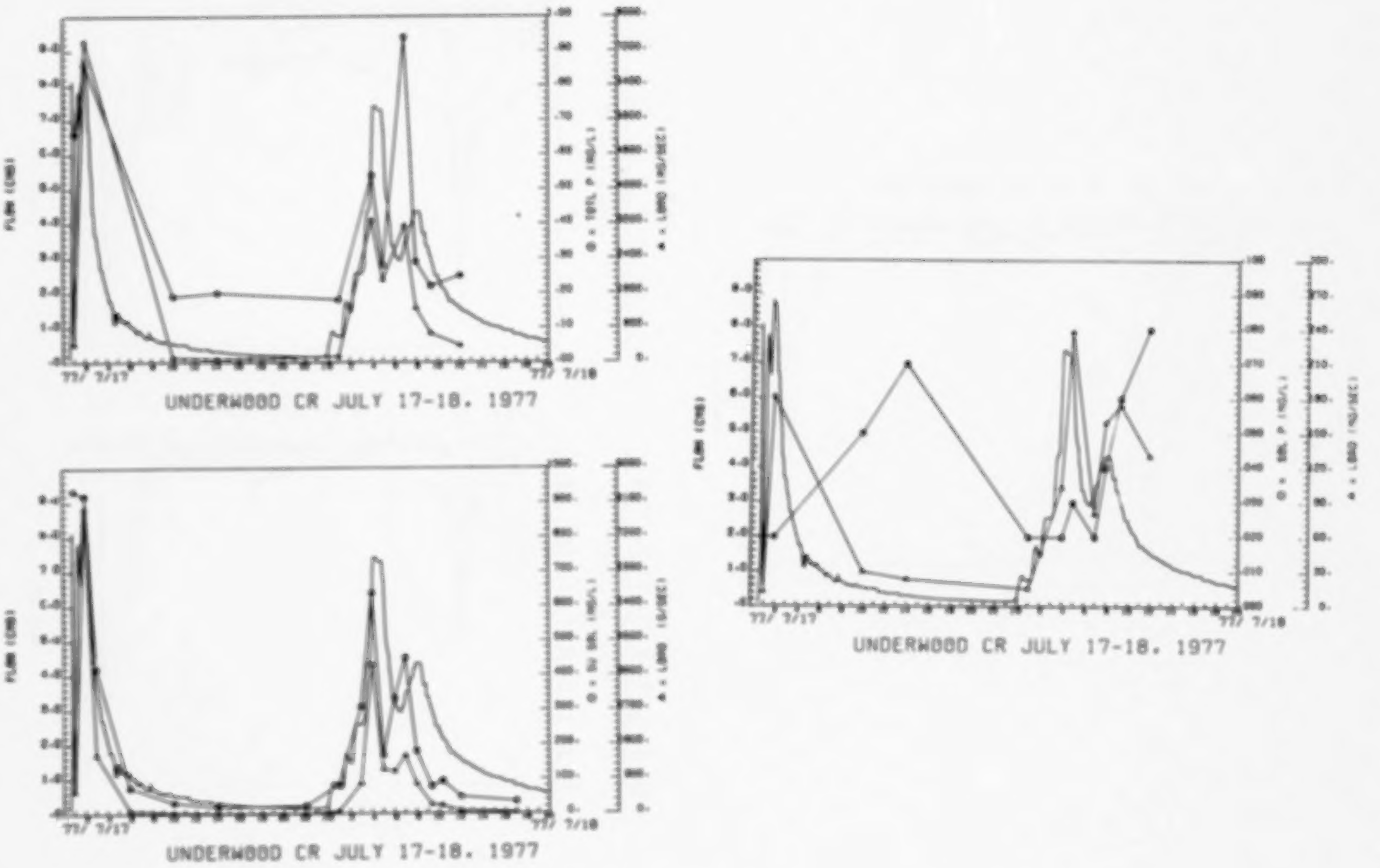


Fig. I-A-7. Flow and parameter concentrations and loading rates for event on August 3-6, 1977 at Underwood Creek (413007).

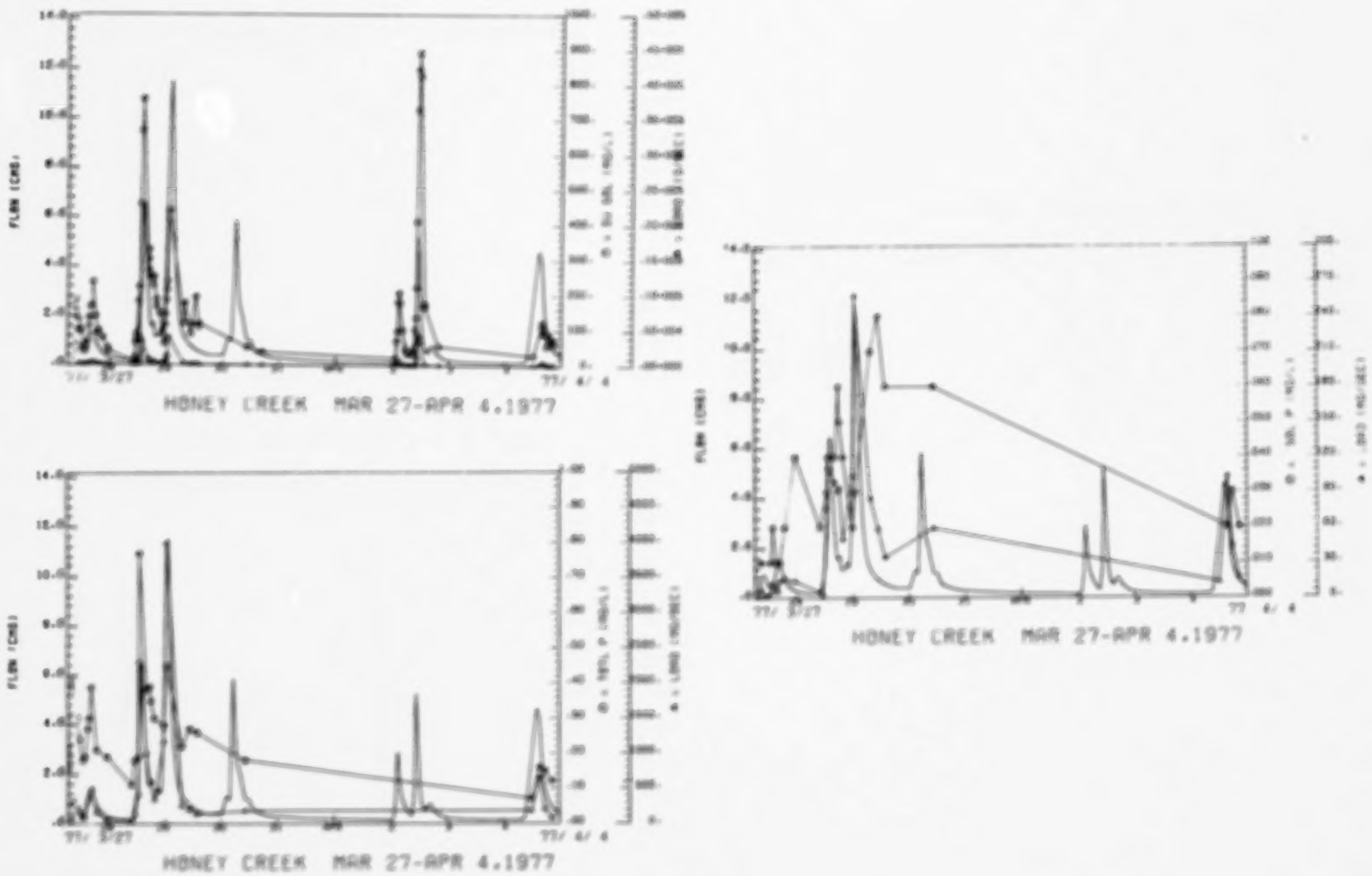


Fig. I-4-8. Flow and parameter concentrations and loading rates for event on March 27-April 14, 1977 at Honey Creek (413006).

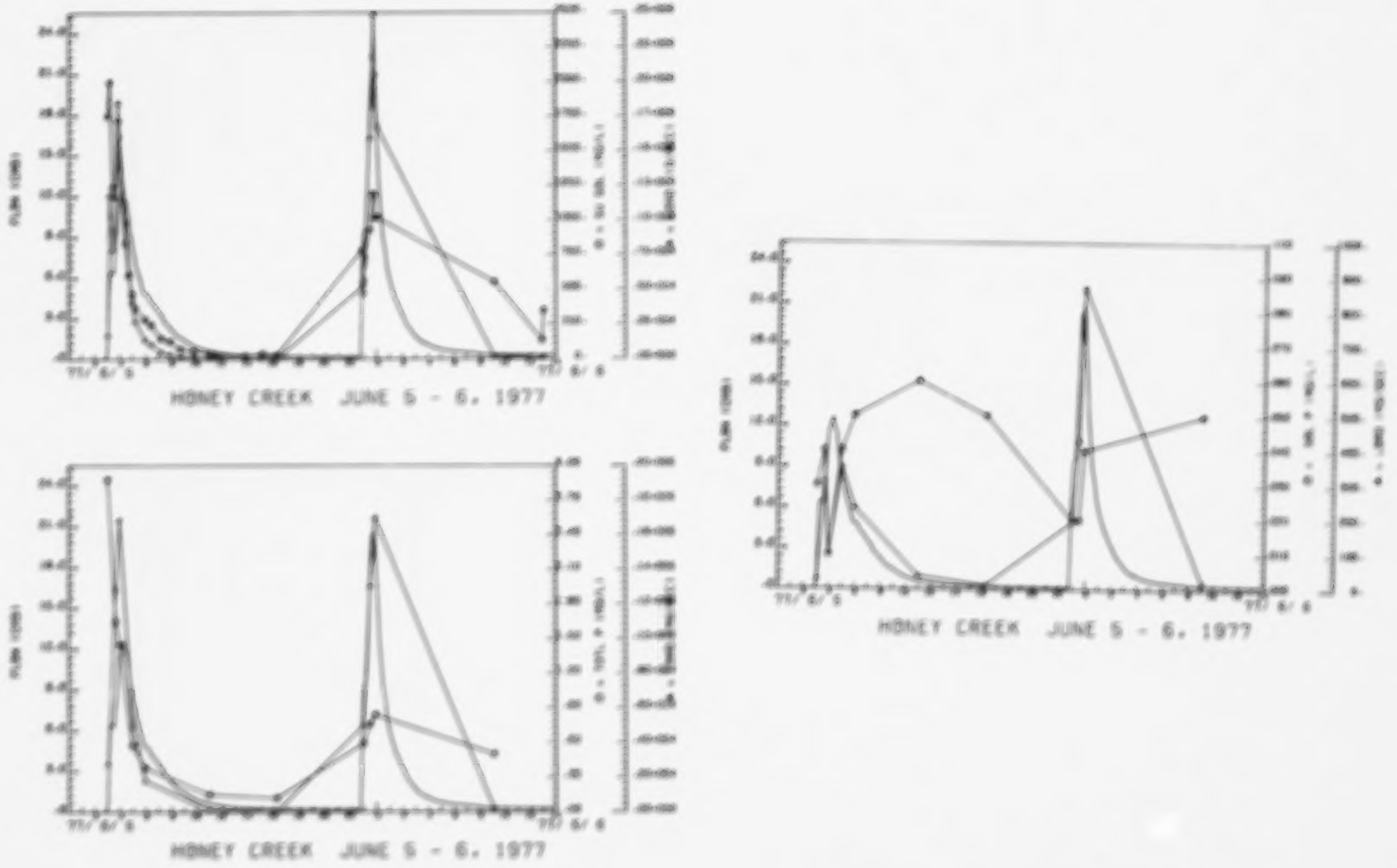


Fig. I-6-9. Flow and parameter concentrations and loading rates for event on June 5-6, 1977 at Honey Creek (413006).

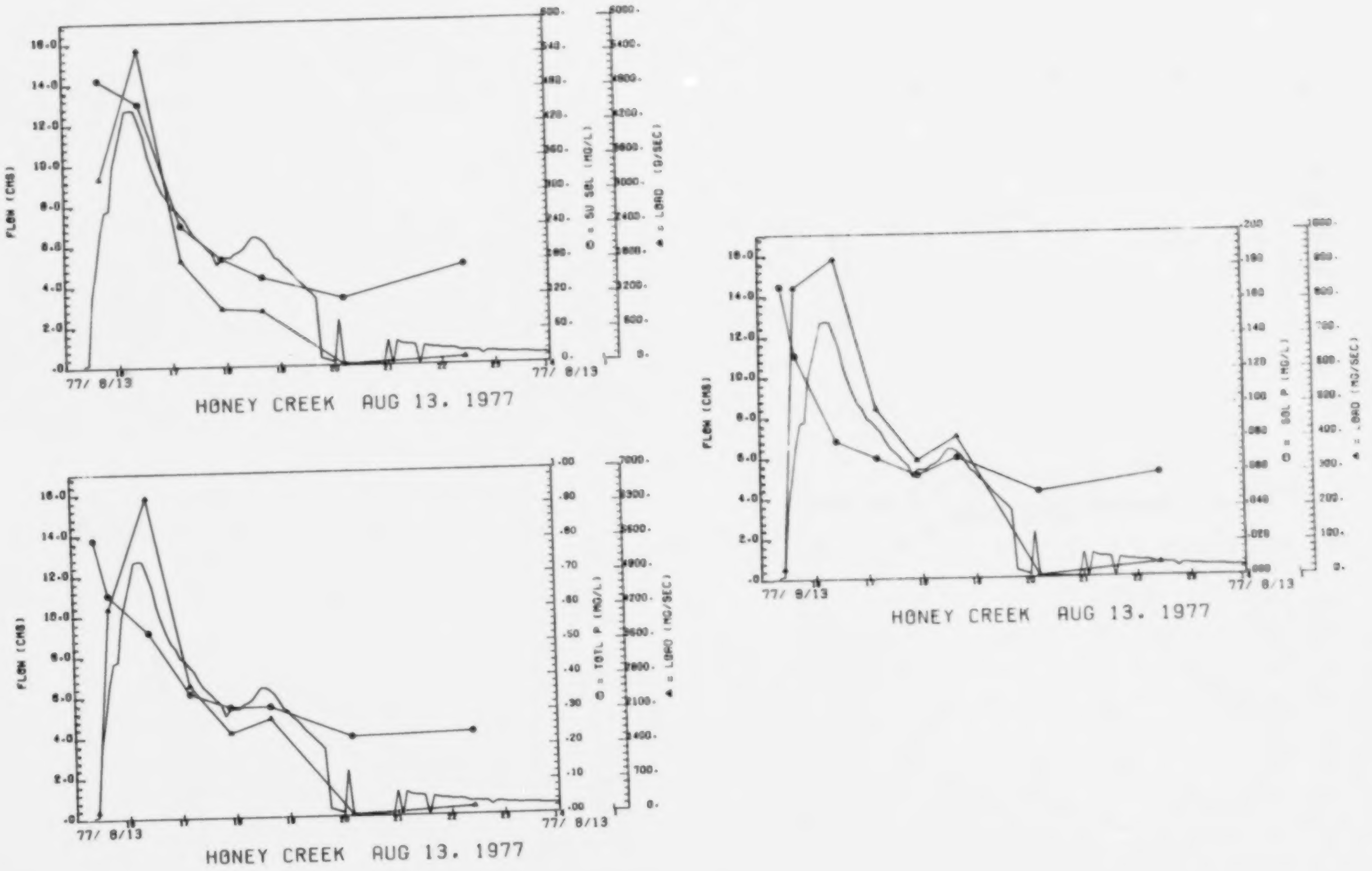


Fig. I-A-10. Flow and parameter concentrations and loading rates for event on August 13, 1977 at Honey Creek (413006).

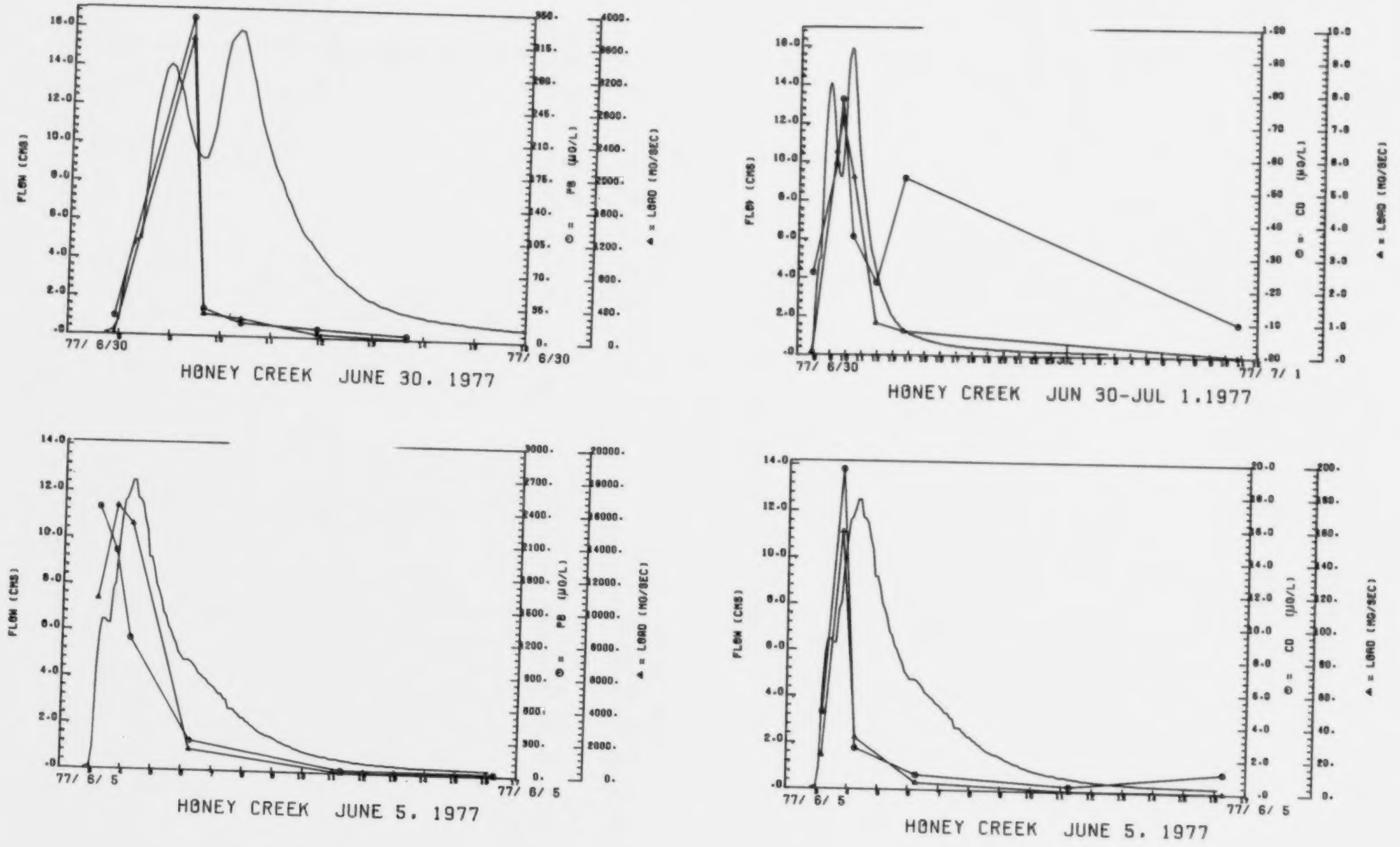


Fig. I-A-11. Flow and metal concentrations and loading rates for events on June 30 and August 20, 1977 at Honey Creek (413006).

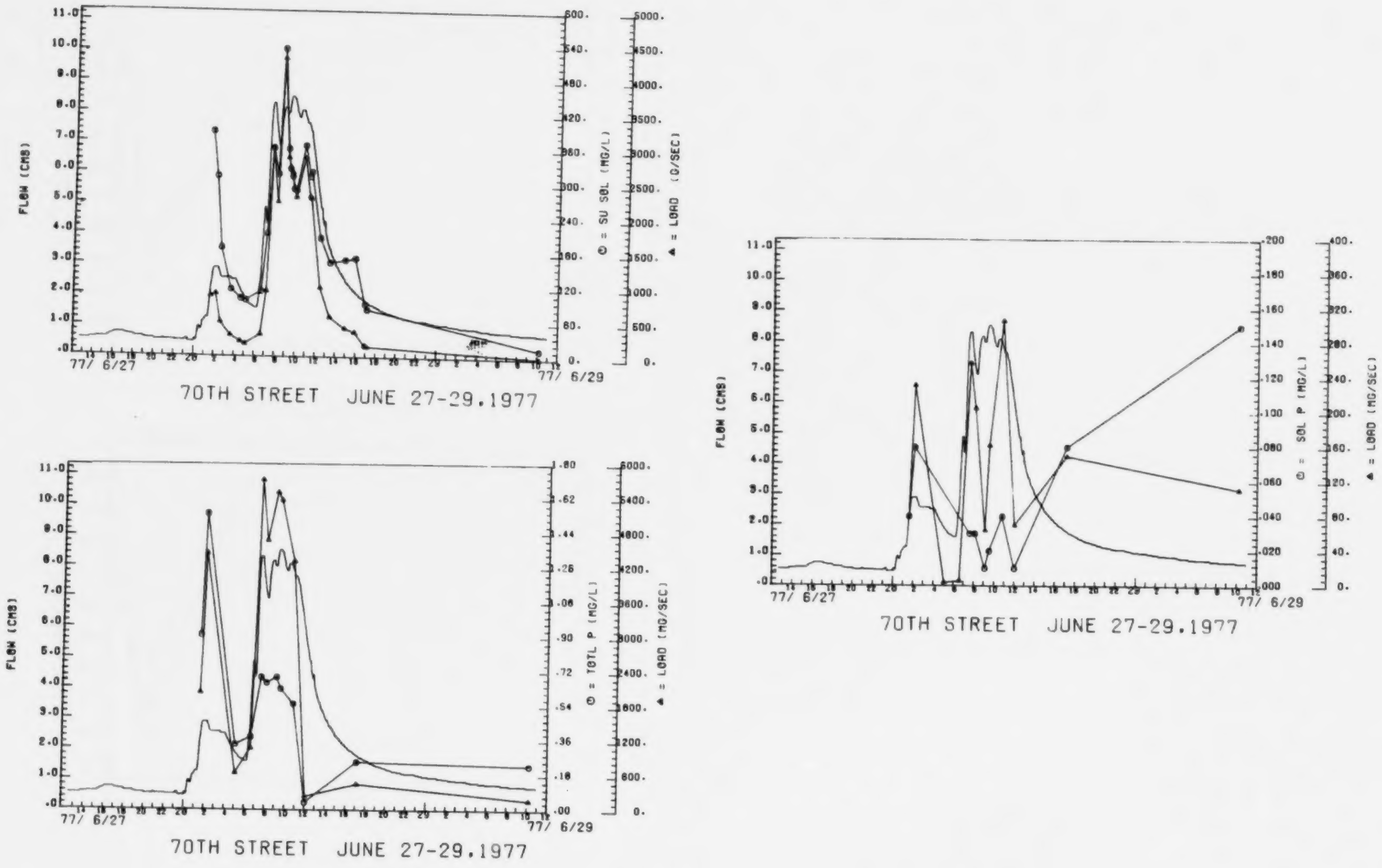
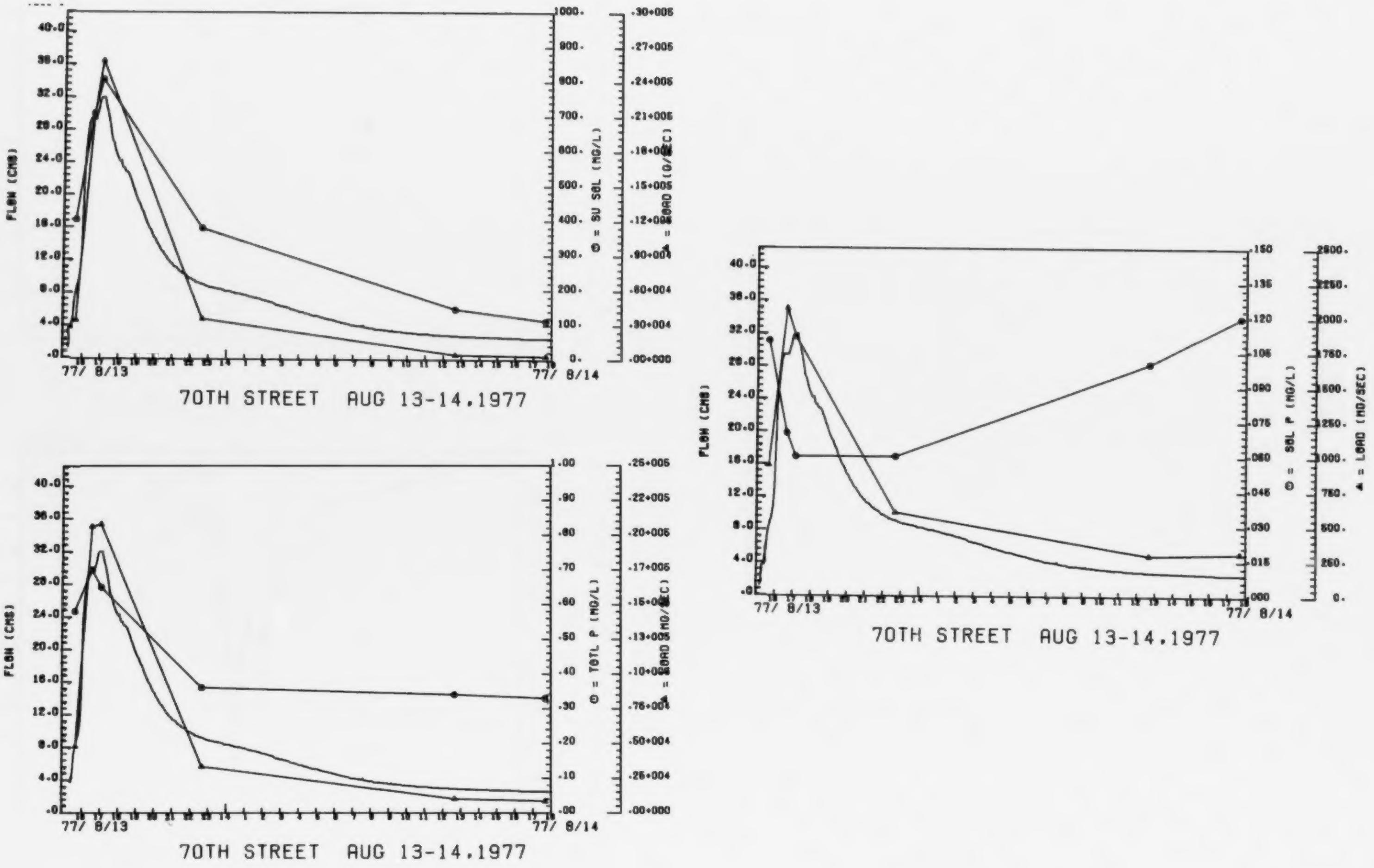


Fig. I-A-12. Flow and parameter concentrations and loading rates for event on June 27-29, 1977 at 70th St. (413005).

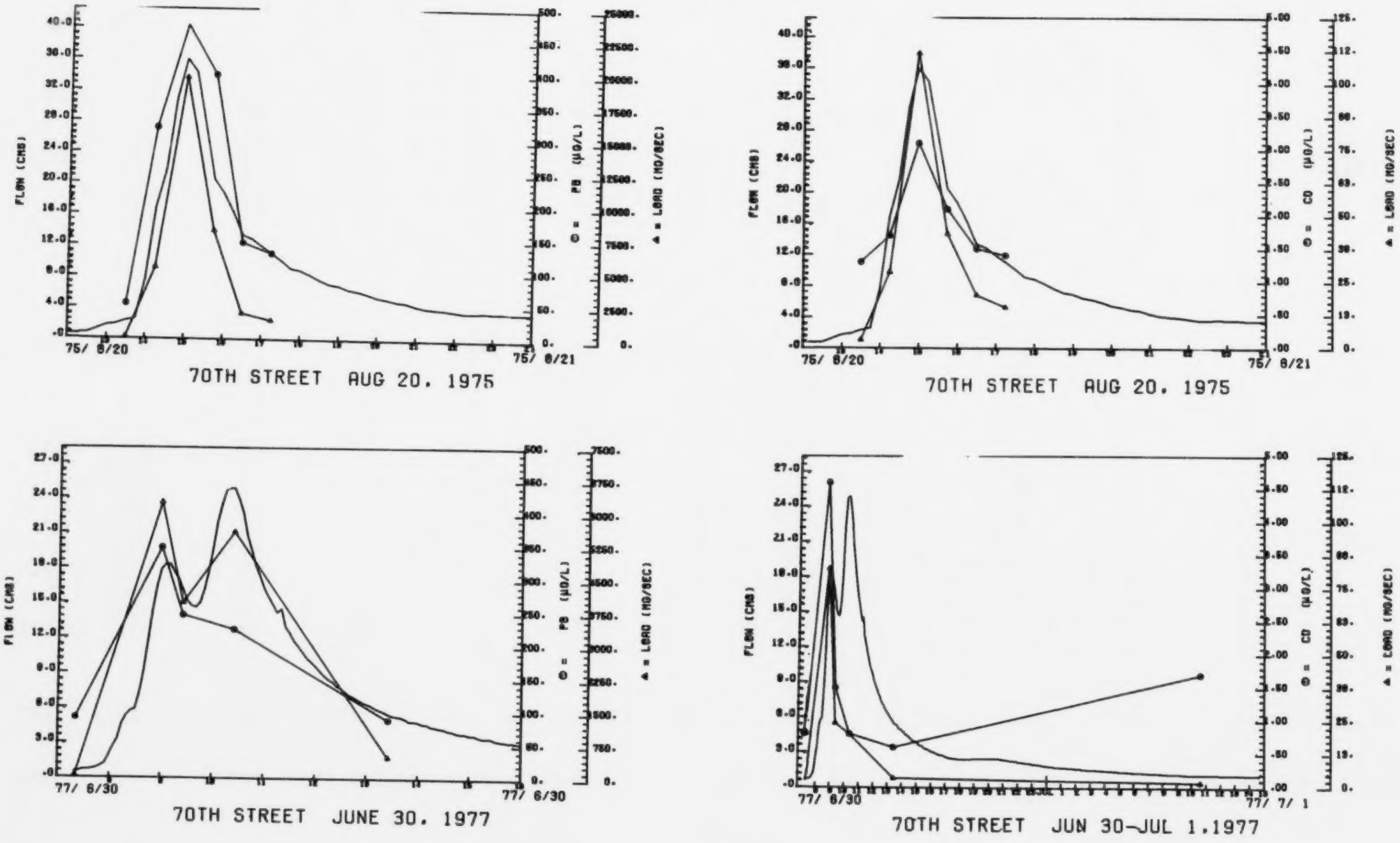


70TH STREET AUG 13-14.1977

70TH STREET AUG 13-14.1977

70TH STREET AUG 13-14.1977

Fig. I-A-13. Flow and parameter concentrations and loading rates for event on August 13-14, 1977 at 70th St. (413005).


70TH STREET AUG 20. 1975

70TH STREET AUG 20. 1975

70TH STREET JUNE 30. 1977

70TH STREET JUN 30–JUL 1.1977

Fig. I-A-14. Flow and metal concentrations and loading rates for events on June 30 and August 20, 1977 at 70th St. (413005).

Table I-A-41. Flows (cms) and parameter concentrations (mg/L) at River Lane (673001) for selected events

DATE	TIME	FLOW	ORG N	AMNM N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
770328	1140	.42	1.30	.51	3.40	.14	.031	80.	855.	19.	5.	
	1640	.62	1.60	.45	3.30	.14	.033	80.	860.	36.	7.	
	2240	.85	1.40	.43	3.20	.13	.045	78.	825.	17.	5.	
770329	0640	1.30	1.40	.47	3.30	.16	.062	82.	815.	16.	4.	
	0940	1.39	1.90	.42	3.20	.22	.060	78.	785.	31.	8.	
	1240	1.42	1.90	.41	3.30	.17	.052	75.	755.	41.	9.	190.
	1250	1.42	1.60	.40	3.20	.18	.062	75.	765.	24.	5.	
	1640	1.33	1.60	.40	3.40	.16	.050	70.	710.	38.	10.	
	2040	1.22	1.60	.41	3.50	.16	.052	70.	705.	36.	10.	
770330	0150	1.10	1.50	.40	3.90	.15	.052	65.	700.	31.	9.	
	0415	1.19	1.70	.39	4.20	.16	.057	65.	715.	27.	10.	
	1110	1.30	1.80	.38	4.80	.15	.055	65.	700.	29.	10.	
770402	1616	.88	2.00	.32	5.80	.12	.050	70.	725.	14.	2.	
	1910	1.02	1.80	.30	5.90	.13	.049	70.	745.	7.	1.	
	2310	1.25	1.90	.32	5.60	.15	.046	68.	740.	10.	2.	190.
770804	1500	.20	2.70	.04	.02	.44	.053					
	1900	.74	2.70	.09	.02	.48	.088			99.		
	2300	1.05	2.30	.37	.39	.54	.162			95.		
770805	0100	1.30	7.30	1.10	.75	1.52	.540			396.		234.
	1435	2.01	1.40	.28	.98	.39	.240			50.		110.
	2345	1.42	1.40	.27	1.16	.36	.230			49.		
770806	0945	1.02	1.70	.50	1.39	.38	.250			36.		
	1845	.82	1.80	.59	1.52	.39	.250			25.		

Table I-A-42. Flows (cms) and parameter concentrations (mg/L) at Pilgrim Road (683002) for selected events

DATE	TIME	FLOW	ORG N	AMNM N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
770327	1330	.68	1.40	.05	2.30	.14	.029	88.	735.	50.	14.	200.
	1530	.76	1.40	.04	2.40	.14	.031	90.	735.	40.	10.	200.
	1730	.74	2.60	.27	2.40	.25	.031	100.	755.	38.	14.	200.
	2330	.71	1.40	.14	2.70	.12	.019	110.	785.	21.	7.	210.
770402	1745	1.95	1.60	.19	4.50	.25	.056	76.	800.	182.	16.	
	1945	1.90	1.70	.19	4.10	.27	.060	75.	750.	136.	12.	
770403	0440	2.01	1.50	.15	4.70	.13	.049	80.	690.	25.	5.	
	1440	1.95	1.60	.16	4.70	.15	.061	75.	710.	12.	2.	
770404	1135	1.70	1.50	.07	4.10	.13	.059	70.	635.	16.	2.	
	1335	2.04	1.60	.10	4.00	.12	.054	72.	640.	32.	5.	
	1935	2.01	1.50	.12	3.80	.16	.063	75.	625.	24.	3.	
	2235	2.01	1.50	.10	3.80	.15	.059	75.	630.	15.	3.	
770803	2205	1.05	1.20	.04	.33	.34	.185	85.	705.	111.	13.	224.
770804	0005	.14	1.00	.07	.44	.34	.147	63.	535.	139.	15.	
	0350	.12	1.30	.05	.43	.25	.104			76.		145.
	1550	2.21	1.30	.04	.45	.34	.084			372.		152.
	1650	.79	1.30	.04	.43	.35	.103			232.		
	2050	.48	1.20	.06	.39	.22	.086			86.		145.
	2250	.65	1.20	.05	.40	.24	.093			72.		
770805	0150	.99	1.10	.05	.39	.25	.108			80.		142.
	1530	1.70	1.40	.30	.80	.27	.130			50.		
	1730	1.67	1.40	.30	.95	.29	.149			32.		
	1930	1.70	1.50	.28	1.00	.28	.156			32.		154.
770806	0430	1.78	1.30	.14	1.07	.31	.182			25.		
	0030	1.78	1.40	.20	1.10	.28	.167			30.		136.
	1425	1.67	1.30	.12	1.15	.25	.181			16.		
	1825	1.53	1.20	.16	1.21	.26	.188			14.		
770807	1325	.91	1.60	.17	1.34	.25	.188			10.		208.
770808	0525	.74	1.70	.15	1.25	.25	.167			18.		
770809	1340	1.16	1.70	.08	1.38	.29	.131	50.		135.		200.
	1440	.65	1.60	.10	1.29	.27	.142	50.		99.		196.
	1740	.65	1.60	.08	1.24	.26	.129	53.		82.		

Table I-A-43. Flows (cms) and parameter concentrations (mg/L) at 124th Street (683001) for selected events

DATE	TIME	FLOW	ORG N	AMNM N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
760505	1730	3.11	.88	.14	1.72	.19	.110	78.	600.	28.	11.	
	1930	4.11	1.20	.18	1.45	.38	.102	74.	710.	178.	26.	
	2130	5.41	1.00	.21	1.31	.37	.102	80.	700.	152.	22.	
760506	0130	6.43	1.10	.25	1.04	.29	.100	70.	535.	107.	12.	178.
	1100	4.90	.82	.20	.92	.21	.110	70.	515.	46.	12.	
760828	0110	1.19	1.51	.17	2.00	.86	.660	230.	905.	27.	7.	
	0210	1.16	2.41	.11	1.12	.93	.220	100.	995.	524.	72.	
	0510	.51	1.50	.18	1.52	.88	.700	195.	765.	59.	10.	
	0810	1.39	1.59	.41	1.61	.88	.580	190.	765.	93.	16.	
	1510	.51	1.44	.78	1.31	.60	.390	100.	495.	49.	9.	
760919	1630	.29	1.54	.26	4.30	.88	.650	280.	975.	36.	8.	244.
	1730	.21	1.53	.27	4.20	.90	.640	255.	980.	42.	11.	240.
	1830	.54	1.63	.29	3.80	1.00	.620	220.	910.	45.	11.	218.
	2325	.22	1.50	.42	4.20	.85	.630	240.	950.	40.	9.	226.
760920	0125	.88	1.58	.59	4.00	.97	.640	235.	980.	75.	21.	222.
	0225	.96	1.54	.75	3.50	.90	.640	190.	910.	80.	21.	216.
	0725	.45	1.51	2.10	3.60	1.04	.810	220.	930.	60.	17.	228.
	1250	.23	1.37	1.10	3.00	.85	.600	170.	750.	47.	14.	184.
770717	0100	2.01	2.50	.13	.89	.79	.076	43.	1315.	980.	112.	60.
	0200	1.08	2.20	.13	1.13	.74	.440	210.	960.	137.	18.	181.
	0255	1.16	1.10	.15	1.12	.75	.460	205.	945.	113.	14.	
	0555	.68	1.40	.24	1.36	.70	.370	190.	885.	180.	17.	
	0855	.96	1.50	.39	1.31	.65	.340	175.	770.	139.	16.	
	1455	.42	1.30	.52	1.54	.62	.390	215.	785.	57.	13.	

Table I-A-44. Flows (cms) and parameter concentrations (mg/L) at Appleton Avenue (413008) for selected events

DATE	TIME	FLOW	ORG N	AMMM N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
770328	1515	2.46	2.60	.37	1.21	.70	.008	160.	1475.	796.	88.	
	1715	2.49	2.10	.18	1.23	.99	.008	120.	2085.	1492.	100.	
	1830	1.78	2.20	.21	1.44	1.20	.022	120.	2125.	1516.	92.	
	2045	.85	1.60	.18	1.46	.47	.034	200.	1175.	328.	32.	
770329	0045	2.41	1.40	.21	1.66	.26	.015	140.	915.	200.	22.	
	0245	4.25	2.40	.10	1.07	.71	.015	100.	1365.	816.	60.	
	0445	4.79	1.60	.11	1.52	.53	.029	80.	910.	316.	32.	
	0745	2.44	2.00	.12	1.25	.80	.021	60.	1460.	868.	56.	
770402	0845	.27	1.60	.30	5.50	.04	.008	185.	1045.	53.	8.	
770803	2215	.42	1.40	.05	.39	.42	.009	15.	800.	660.	34.	70.
	2245	.54	1.20	.03	.17	.11	.007	100.	685.	92.	8.	192.
	2345	.40	1.10	.10	.27	.29	.020	65.	745.	276.	20.	148.
770804	0115	.57	1.50	.04	.32	.23	.029	88.	630.	134.	14.	134.
	0315	.45	1.60	.09	.43	.81	.029	63.		1086.	54.	
	0515	.28	.90	.06	.43	.30	.032	60.	600.	137.	9.	
	1745	.24	.80	.02	.33	.17	.013			138.		
	1845	.37	.70	.03	.38	.14	.012			93.		98.
	1945	.45	.80	<.02	.23	.13	.015			68.		114.
	2115	.42	1.20	.03	.32	.24	.013			321.		
	2245	.31	1.00	.02	.37	.14	.011			128.		
770805	0115	.20	1.00	<.02	.43	.22	.012			246.		
770813	1515	1.50	1.80	.05	.28	.44	.015	10.		654.	56.	
	1545	3.26	1.30	.10	.29	.50	.025	12.		670.	55.	58.
	1615	3.43	1.50	.09	.40	.59	.037	25.		934.	70.	78.
	1715	3.37	1.60	.04	.36	.42	.063	60.		527.	36.	
770814	0145	.57	.90	.03	.48	.18	.022	45.		130.	14.	
	1215	.27	1.20	.05	.47	.16	.024	54.		98.	10.	

Table I-A-45. Flows (cms) and parameter concentrations (mg/L) at Honey Creek (413006) and Underwood Creek (413007) for selected events

DATE	TIME	FLOW	ORG N	AMMM N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
						HONEY CREEK						
770421	0945	.09	1.10	.08	1.55	.09	.004	195.	675.	10.	5.	
	1240	.91	2.20	.04	1.11	.35	.023	109.	615.	150.	38.	
	1325	.99	2.30	.04	1.06	.40	.014	75.	520.	198.	46.	81.
	1355	1.19	2.30	.05	.88	.39	.015	44.	435.	222.	46.	74.
	1440	1.59	1.90	.04	.79	.32	.022	47.	225.	164.	40.	
	1725	.51	1.00	.04	.65	.14	.012	69.	240.	38.	11.	
770611	0245	1.61	1.70	.08	.66	.30	.037	210.	1040.	311.	44.	
	0315	5.07	2.20	.49	1.02	.68	.132	25.	855.	609.	80.	
	0335	6.09	1.60	.45	1.04	.46	.045	19.	970.	752.	105.	54.
	0350	5.49	2.10	.46	.97	.50	.040	25.	725.	560.	79.	
	0420	7.22	1.70	.47	1.14	.38	.038	21.	625.	465.	68.	54.
	0450	5.78	1.70	.40	1.09	.42	.064	17.	635.	447.	61.	
	0605	2.52	1.40	.41	1.11	.30	.031	30.	515.	359.	49.	
	1205	.37	1.50	.37	1.09	.34	.032	24.	455.	290.	36.	
770630	0755	.31	.50	.07	.32	.08	.022	163.	595.	42.	6.	
	0835	10.05	1.40	.02	.35	.40	.078	14.		275.	38.	
	0920	10.68	1.90	.08	.30	.48	.040	13.	665.	470.	58.	30.
	0940	9.23	2.60	.03	.34	.30	.028	12.	525.	365.	38.	28.
	0955	12.60	1.20	.03	.32	.26	.030	13.	410.	275.	35.	
	1010	15.60	1.10	.08	.30	.31	.053	11.		334.	39.	
	1025	15.04	1.30	.09	.24	.36	.053	11.	580.	385.	54.	30.
	1040	12.06	1.20	.06	.24	.32	.045	14.		263.	27.	
	1155	4.39	1.40	.18	.37	.42	.098	35.	405.	260.	33.	
	1300	1.95	1.10	.04	.40	.33	.068	45.	495.	326.	27.	
	1335	1.36	1.00	.04	.48	.32	.068	53.	545.	360.	33.	
	1340	1.33	1.40	.04	.47	.42	.067	51.		359.	36.	
770805	1235	.18	2.80	.03	.27	.48	.007			324.		
	1238	2.31	4.10	.08	.67	.70	<.004			644.		128.
	1250	5.18	4.20	.19	.73	.86	.011			806.		98.
	1305	4.39	2.60	.21	.58	.52	.019			452.		
	1505	2.32	2.00	.22	.73	.30	.018			240.		
	1510	2.55	1.00	.16	.71	.20	.018			198.		
	1615	5.32	.90	.05	.58	.20	.015			266.		
	1900	1.08	.80	.04	.47	.15	.022			102.		
770606	0000	.22	.80	<.02	.48	.12	.020			39.		
						UNDERWOOD CREEK						
770627	1712	.09	.60	.02	<.02	.07	.013	80.	515.	2.	2.	
770628	0112	.50	2.30	<.02	1.48	.27	<.004	138.	585.	91.	29.	
	0612	.18	1.50	<.02	1.30	.16	.011	162.	595.	35.	15.	
	0712	.80	1.90	<.02	.94	.34	.006	78.	685.	219.	37.	
	1112	1.01	1.30	.15	.89	.29	.088	30.	255.	33.	21.	52.

Table I-A-46. Flows (cms) and parameter concentrations (mg/L) at 70th Street (413005) and Falk Corporation (413004) for selected events

DATE	TIME	FLOW	ORG N	AMMN N	NITRAT	TOTL P	SOL P	CHLOR	TOTSOL	SUSSOL	VOLSOL	ALKAL
						70TH STREET						
760505	1755	4.39	1.60	.13	1.18	.35	.080	90.	720.	120.	28.	
	1855	26.90	2.20	.20	.74	.67	.038	38.	825.	540.	78.	
	1955	47.86	2.10	.12	.46	.62	.039	26.	800.	594.	72.	
	2050	47.29	1.80	.22	.51	.58	.060	30.	670.	432.	60.	
	2340	19.40	1.40	.24	.65	.42	.093	36.	520.	226.	44.	
760506	1020	8.86	1.20	.34	.94	.29	.120	78.	530.	72.	11.	
760728	0728	.46	2.76	.02	.57	.54	.076	145.	862.	98.	39.	190.
	0808	1.16	2.31	.02	.59	.62	.110	140.	865.	150.	40.	198.
	0810	1.19	2.91	.02	.01	.63	.007	140.	990.	180.	46.	192.
	0833	2.17	3.51	.02	.53	.81	.062	115.	1504.	294.	66.	178.
	0903	4.99	5.91	.02	.73	2.10	.510	70.	975.	584.	104.	146.
	0932	6.94	7.70	.03	.44	1.60	.003	95.	1355.	876.	136.	196.
	0935	7.08	5.89	.04	.01	1.30	<.003	110.	1270.	708.	114.	188.
	1000	6.71	5.91	.02	.01	.97	<.003	130.	1150.	477.	91.	204.
	1003	6.63	4.83	.02	.28	1.00	.003	110.	1085.	508.	88.	178.
	1701	1.59	1.40	.03	.72	.38	.085	90.	470.	55.	17.	128.
	1704	1.59	1.29	.02	.70	.34	.087	85.	508.	62.	19.	122.
770611	0230	.96	1.80	.20	1.50	.49	.102	123.	890.	290.	42.	
	0400	15.63	4.30	.59	1.18	1.36	.068	33.	1285.	953.	97.	82.
	0430	16.34	2.70	.48	1.18	.83	.063	42.	960.	624.	67.	86.
	0630	10.14	2.50	.50	1.32	.80	.108	60.	875.	570.	68.	
	0930	7.58	1.90	.46	1.23	.73	.084	48.	960.	666.	53.	
	1230	8.21	2.20	.57	1.39	1.03	.101	68.	1355.	958.	80.	
	1400	8.61	2.80	.14	1.30	1.27	.061	35.	1395.	1112.	106.	
	1810	9.71	2.30	.07	1.44	.83	.069	37.	795.	502.	62.	
	2110	8.30	1.80	.09	1.41	.60	.088	43.	650.	300.	30.	
770803	2145	2.15	1.90	.04	.12	.29	.029	130.	720.	101.	20.	
	2240	11.38	2.90	.06	.18	.74	.036	109.	905.	196.	40.	144.
	2310	14.30	3.70	.05	.36	1.08	.017	63.	1320.	442.	72.	128.
770804	0010	12.15	1.90	.08	.51	.52	.048	50.	710.	1034.	96.	
	0110	7.28	1.90	.10	.52	.65	.046	33.		520.	44.	
	0340	3.60	1.20	.11	.55	.35	.055	35.	435.	216.	20.	
	0635	2.10	1.30	.06	.85	.30	.085	86.		128.	15.	
	1035	1.78	1.00	.04	.63	.20	.073	60.	385.	46.	9.	
						FALK CORPORATION						
770421	0300	2.24	2.00	.04	1.19	.38	.025	125.	635.	96.	17.	
	0900	1.84	2.50	.04	.88	.45	.045	148.	690.	55.	23.	
	1100	1.87	1.70	.02	1.08	.36	.053	130.	600.	46.	11.	
	1500	4.30	2.20	.06	1.09	.50	.126	120.	560.	72.	18.	
	2100	2.49	1.30	.01	.87	.23	.066	140.	550.	24.	6.	
770422	0300	1.98	1.10	.08	.98	.21	.078	155.	620.	13.	3.	

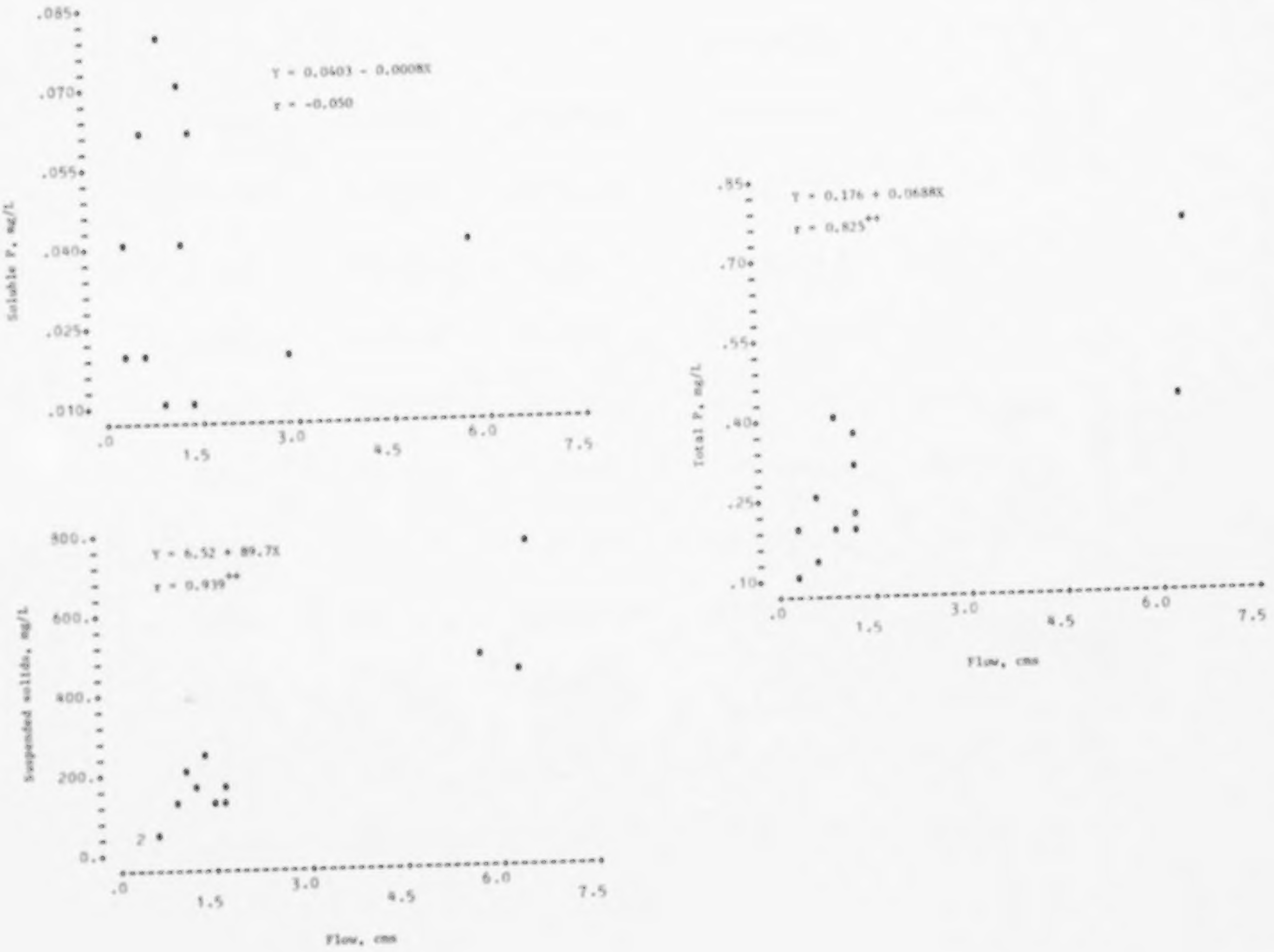


Fig. I-A-15. Relationships of parameter concentrations and flow for event on March 27, 1977 at Honey Creek (413006) (**Significant at P = 0.01).

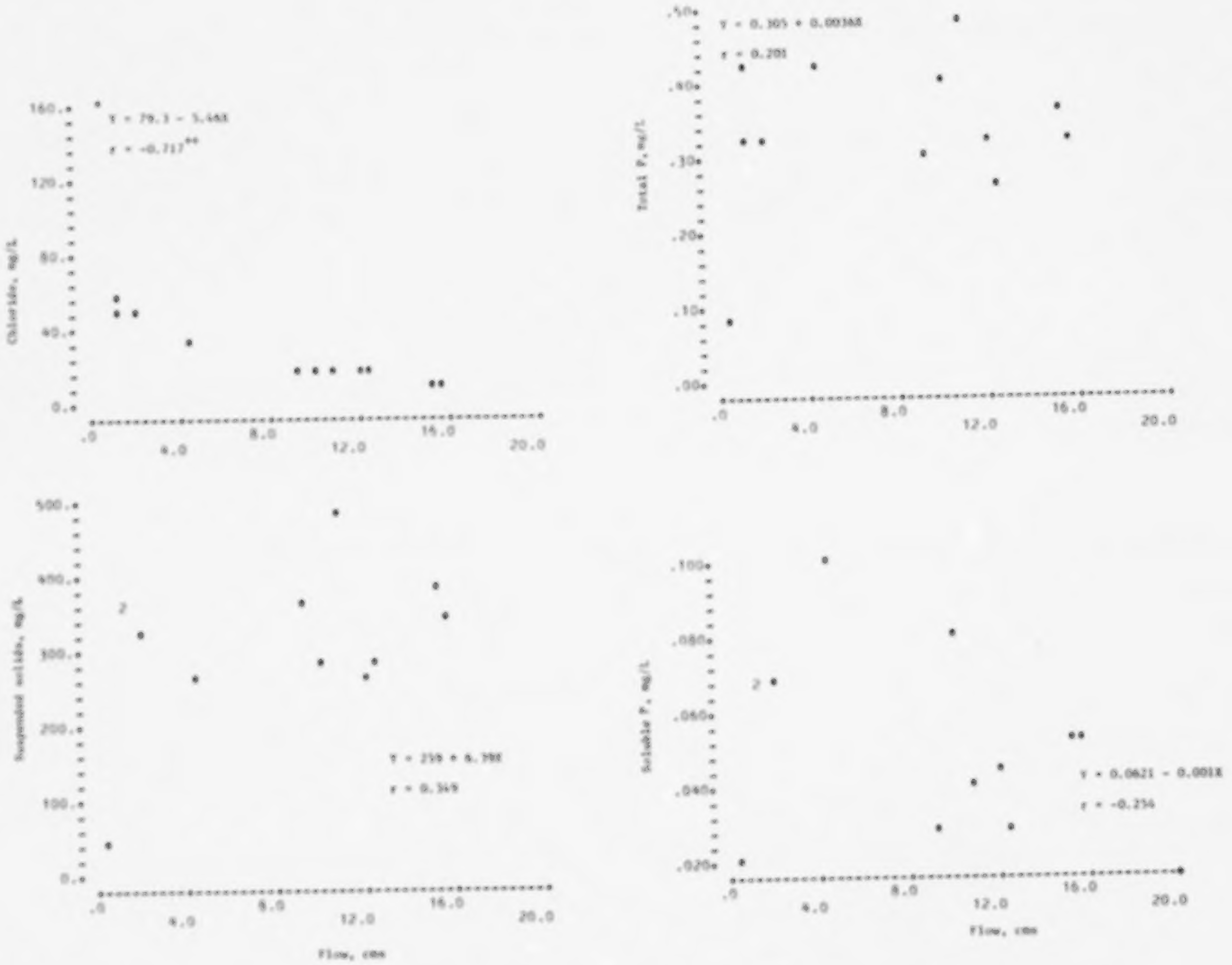


Fig. I-A-16. Relationships of parameter concentrations and flow for event on June 30, 1977 at Honey Creek (413006) (**Significant at P = 0.01).

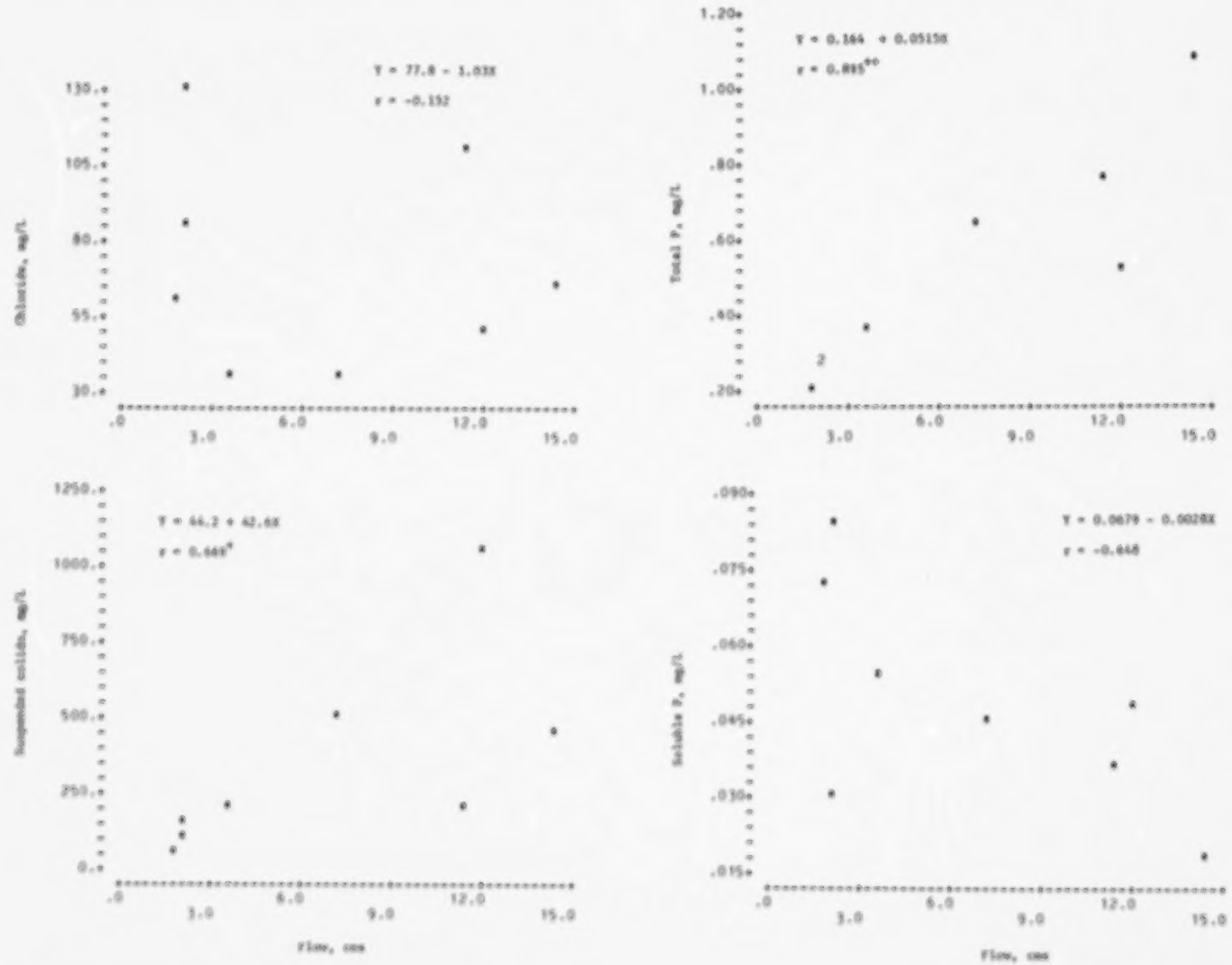


Fig. I-4-17. Relationships of parameter concentrations and flow for event on August 3, 1977 at 70th St. (413005) (*Significant at P = 0.05; **significant at P = 0.01).

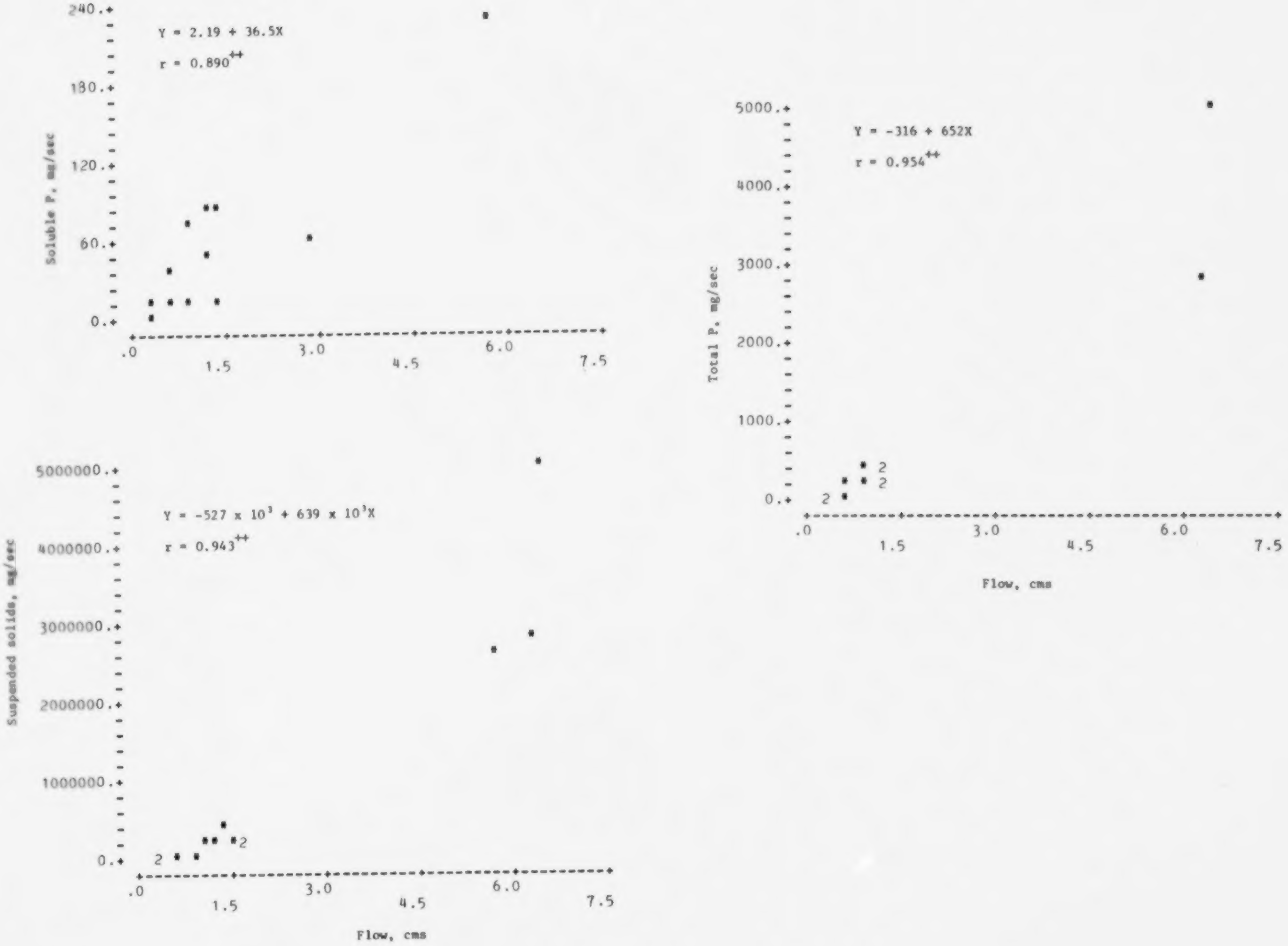


Fig. I-A-18. Relationships of parameter loading rates and flow for event on March 27, 1977 at Honey Creek (413006) ($^{++}$Significant at P = 0.01).

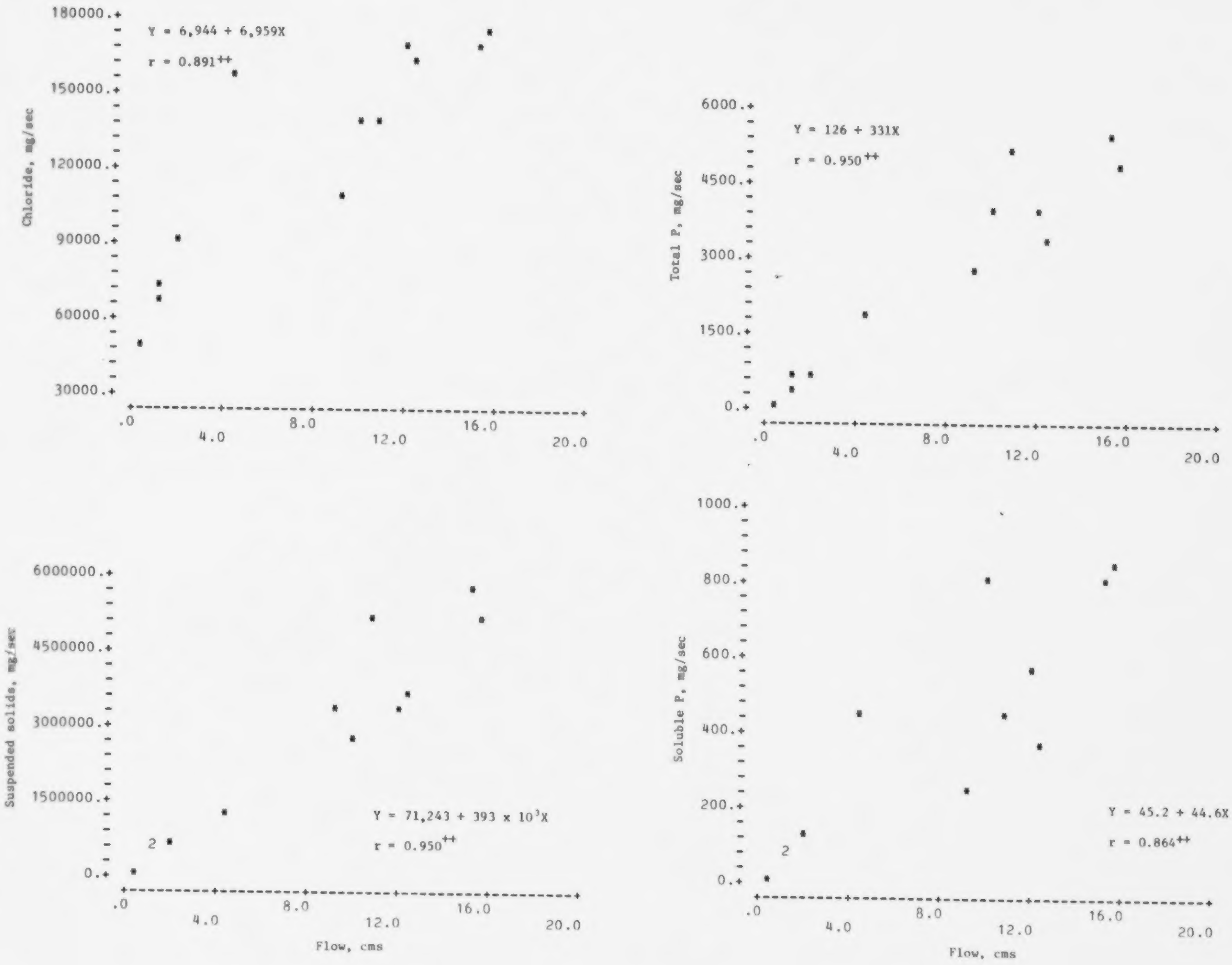


Fig. I-A-19. Relationships of parameter loading rates and flow for event on June 30, 1977 at Honey Creek (413006) (++Significant at P = 0.01).

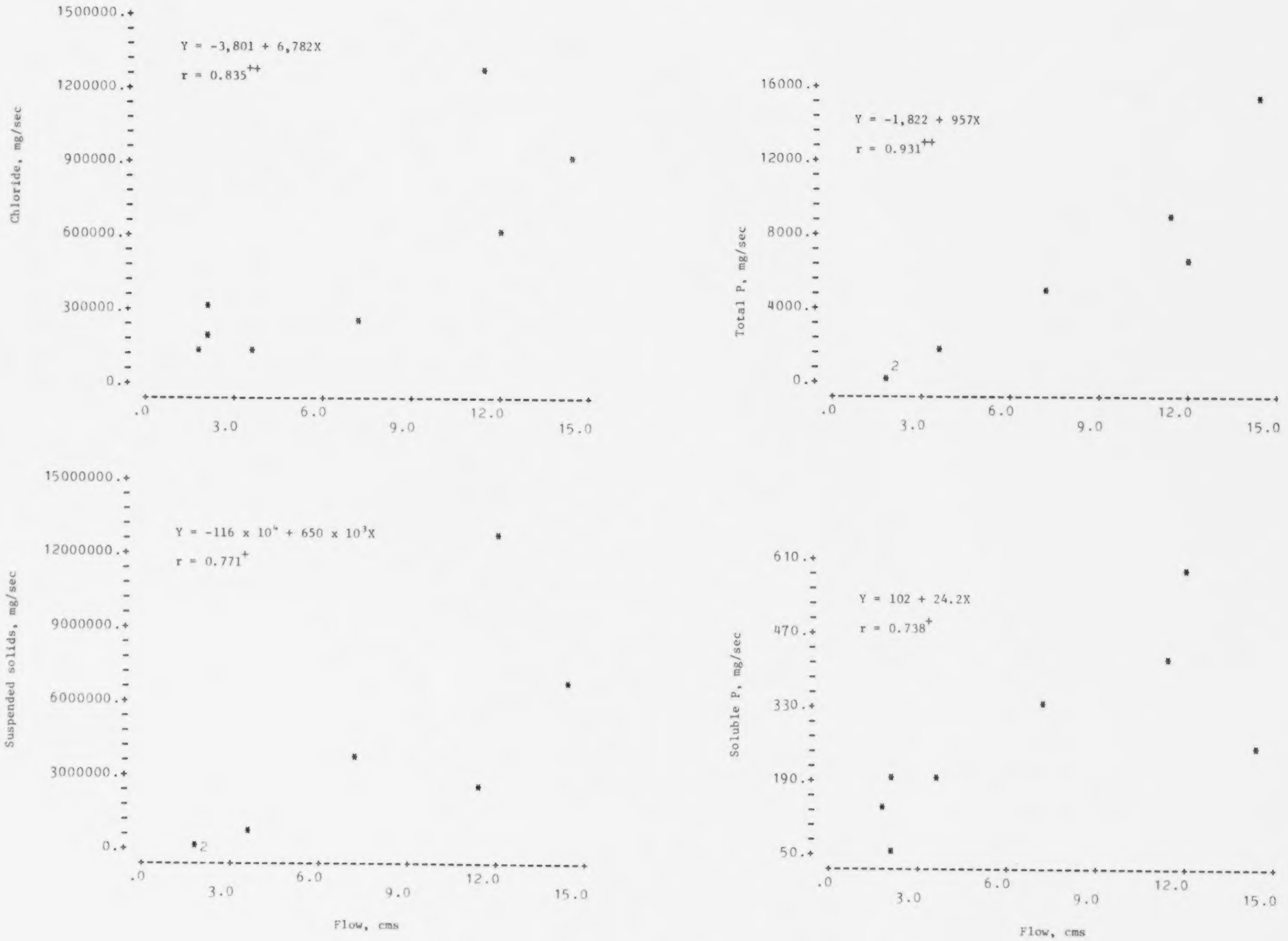


Fig. I-A-20. Relationships of parameter loading rates and flow for event on August 3, 1977 at 70th St. (413005) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

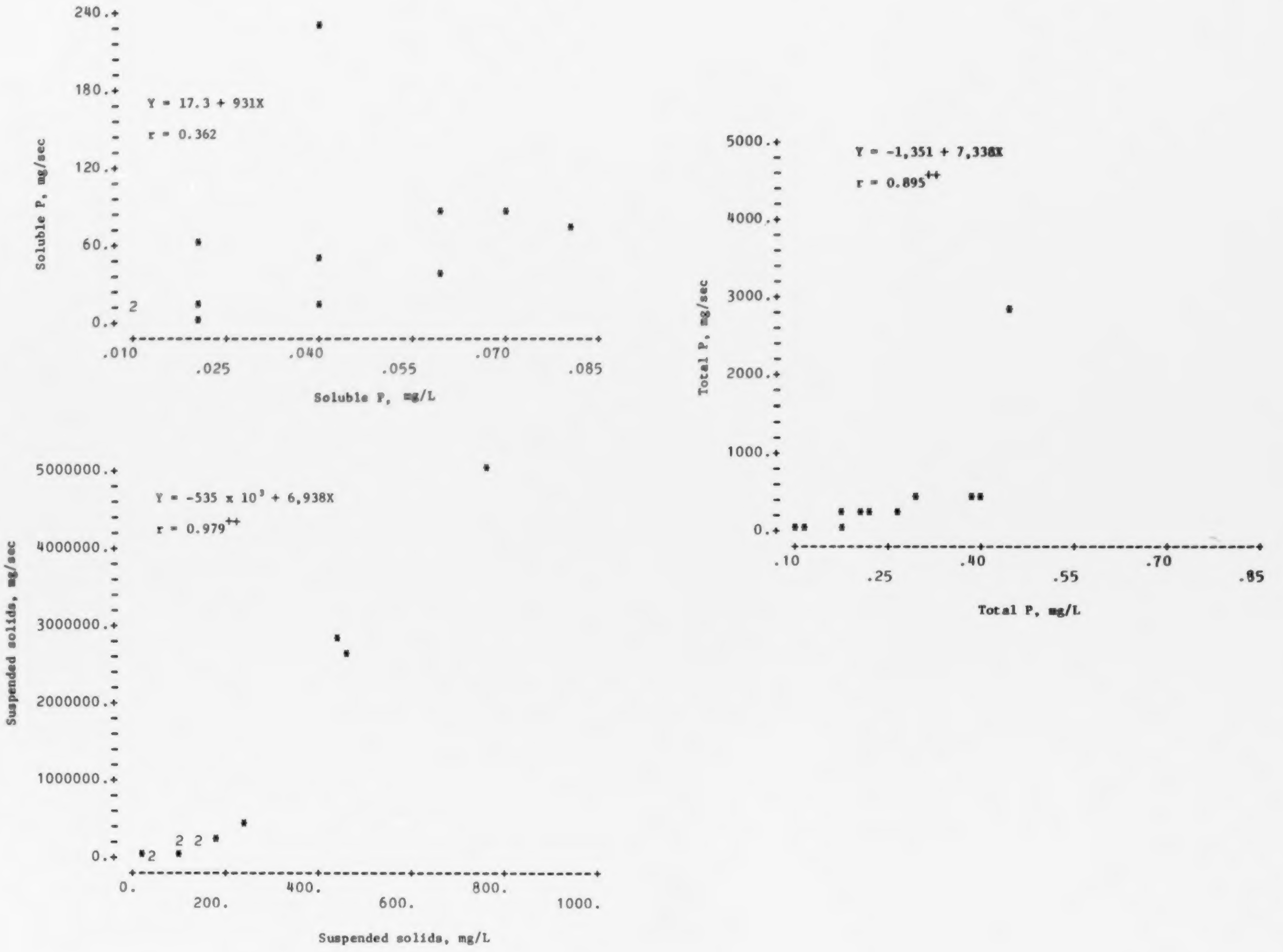


Fig. I-A-21. Relationships of parameter loading rates and concentrations for event on March 27, 1977 at Honey Creek (413006) ($^{++}$Significant at P = 0.01).

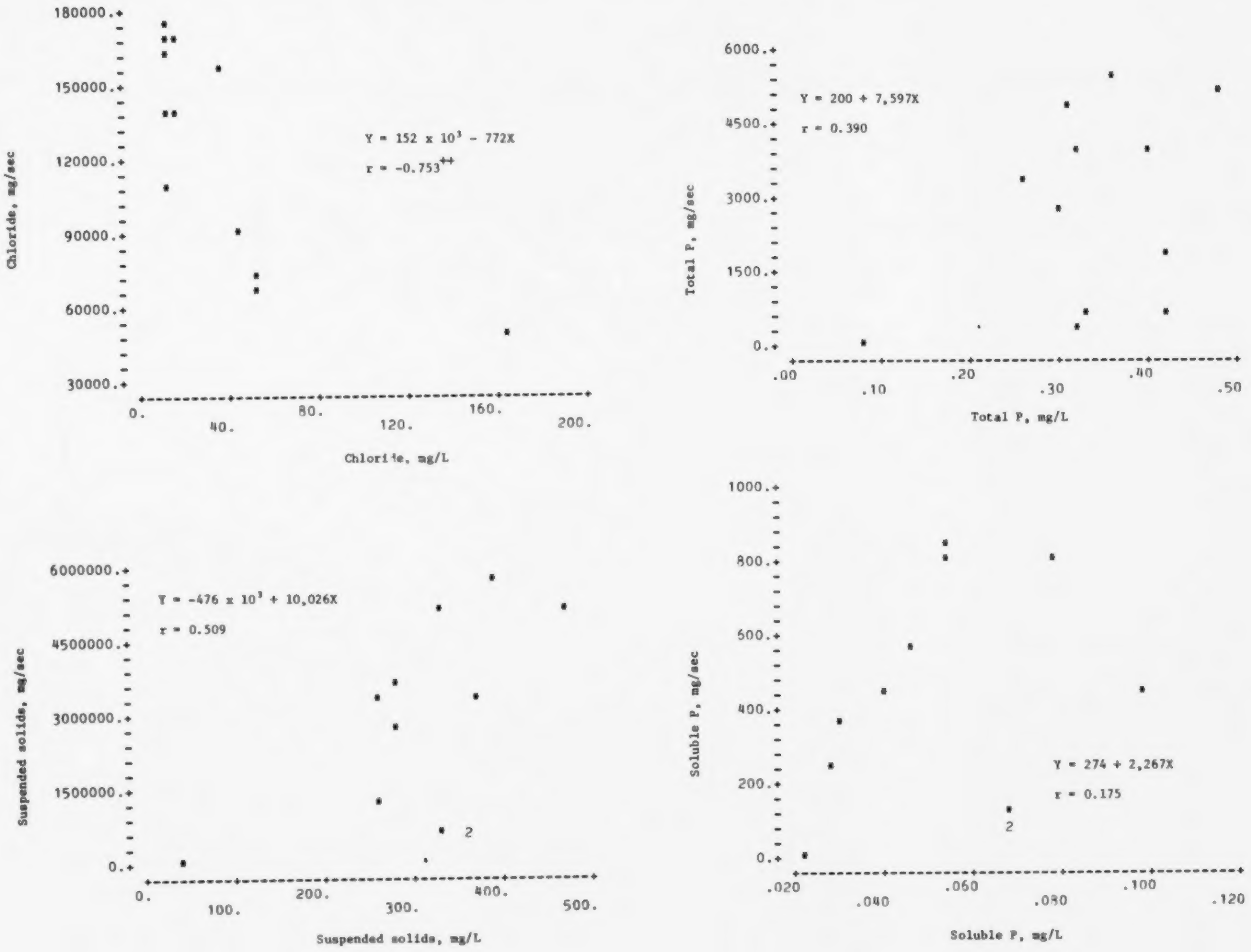


Fig. I-A-22. Relationships of parameter loading rates and concentrations for event on June 30, 1977 at Honey Creek (413006) ($^{++}$Significant at P = 0.01).

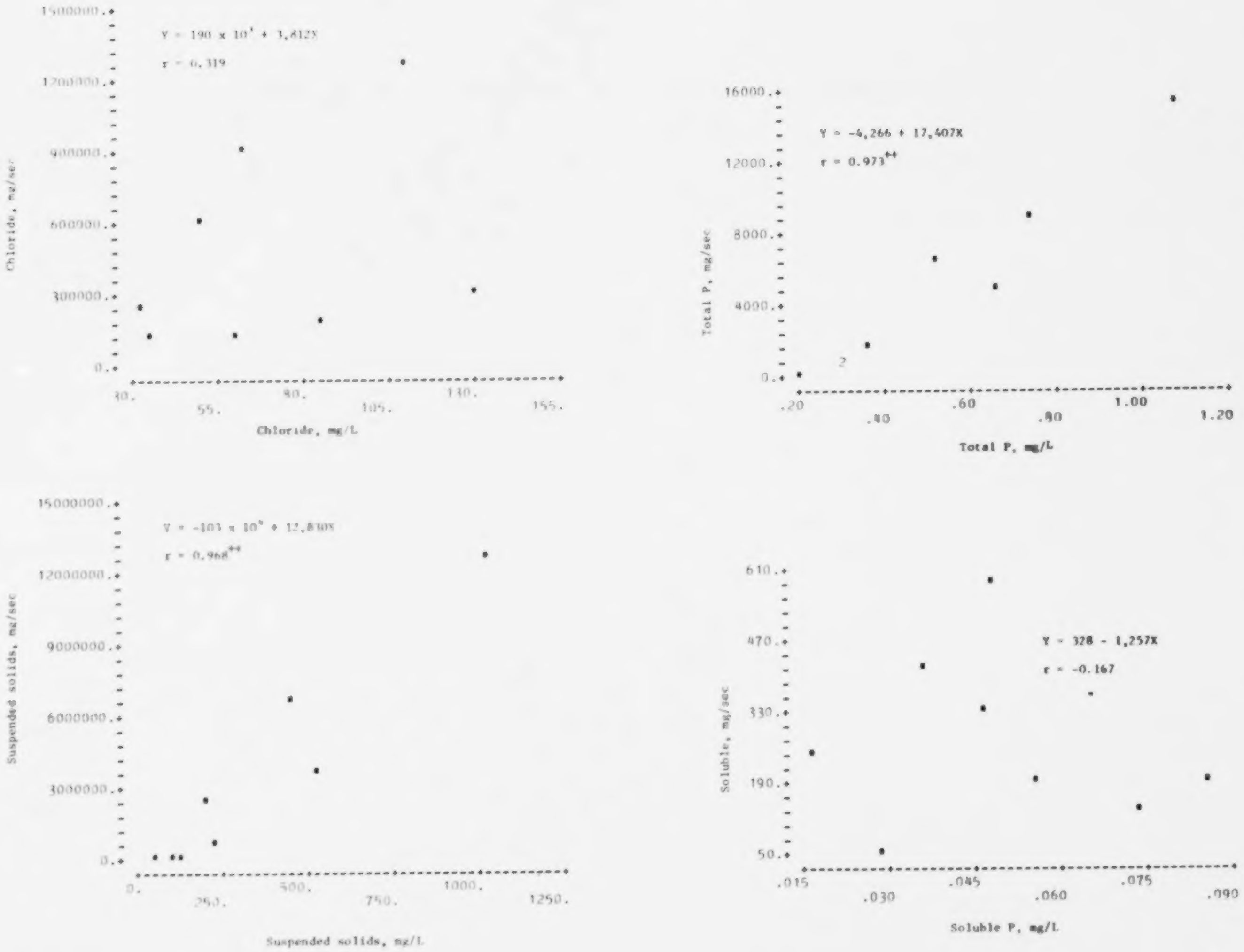


Fig. I-A-23. Relationships of parameter loading rates and concentrations for event on August 3, 1977 at 70th St. (413005) ($^{++}$Significant at P = 0.01).

Table I-A-47. Seasonal and annual event unit area loadings of water (m^3/ha) at the main stem river stations

STORET number	Spring	Summer	Fall	Annual
1975				
673001	390	80	100	570
683002	640	220	130	990
683001	820	340	130	1,290
413008	980	350	190	1,510
413007	240	280	80	600
413006	560	300	210	1,070
413005	980	400	100	1,490
413009	i.d.	i.d.	i.d.	i.d.
413004	i.d.	i.d.	120	i.d.
1976				
673001	270	10	2	280
683002	840	10	3	860
683001	1,450	30	10	1,490
413008	1,800	10	10	1,830
413007	870	60	20	950
413006	1,590	280	90	1,960
413005	1,320	70	30	1,420
413009	570	150	60	780
413004	1,290	70	i.d.	1,360
1977				
673001	50	180	i.d.	328*
683002	60	150	i.d.	300*
683001	210	190	120	520
413008	120	270	i.d.	557*
413007	80	210	90	380
413006	370	810	200	1,380
413005	140	280	100	520
413009	180	330	i.d.	729*
413004	120	290	i.d.	586*

*Loading values are estimated by adding 30% to the sum of spring and summer loadings.

i.d. Data insufficient for determination of loading.

Table I-A-48. Seasonal and annual event unit area loadings* of suspended solids and flow-weighted average concentrations** at main stem river stations

STORET number	Spring Loading, kg/ha	Spring Concentration, mg/L	Summer Loading, kg/ha	Summer Concentration, mg/L	Fall Loading, kg/ha	Fall Concentration, mg/L	Annual Loading, kg/ha	Annual Concentration, mg/L
				1975				
673001	36.7 (4.5)$^{+}$	94	3.6 (0.8)	43	2.0 (5.7)	20	42.3 (6.1)	74
683002	43.2 (7.5)	68	44.1 (19.2)	201	6.8 (1.7)	52	94.1(20.8)	95
683001	56.1(21.4)	68	71.5 (12.8)	210	4.3 (1.2)	33	131 (24.7)	85
413008	238 (61.7)	243	2.2 (50.3)	605	46.4(22.5)	250	497 (81.0)	328
413007	286 (74.6)	1208	178 (55.7)	638	2.8 (9.1)	35	466 (92.8)	782
413006	288 (72.1)	511	147 (24.4)	498	45.9(14.7)	215	480 (77.3)	448
413005	127 (29.6)	129	147 (18.0)	364	14.3 (4.1)	137	288 (35.0)	189
413009	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.
413004	i.d.	i.d.	i.d.	i.d.	13.3 (9.3)	115	i.d.	i.d.
				1976				
673001	12.7 (3.9)	47	0.2 (0.1)	27	0.06 (0.02)	29	13.0 (3.8)	46
683002	36.6(11.4)	43	1.6 (1.0)	109	0.1 (0.1)	37	38.3(11.5)	45
683001	136 (36.8)	94	6.0 (2.7)	192	0.4 (0.1)	58	143 (36.9)	96
413008	467 (131)	259	58.1 (47.6)	4407	1.4 (0.5)	106	527 (136)	288
413007	133 (42.7)	154	37.9 (27.2)	624	7.4 (6.1)	317	178 (49.5)	187
413006	835 (149)	524	76.7 (15.1)	275	10.0 (1.9)	112	922 (150)	470
413005	230 (25.7)	174	36.0 (10.5)	480	4.2 (1.7)	160	271 (27.7)	191
413009	130 (35.4)	226	30.3 (7.8)	203	i.d.	i.d.	160 (36.3)	204
413004	266 (65.8)	206	10.0 (9.0)	135	i.d.	i.d.	276 (66.4)	202
				1977				
673001	1.6 (0.6)	32	13.5 (9.0)	75	i.d.	i.d.	17 (9)$^{++}$	50
683002	7.5 (4.6)	115	39.1 (9.9)	256	i.d.	i.d.	58 (11)$^{++}$	190
683001	44.5 (15.2)	208	80.6(17.2)	377	45.6 (32.8)	380	171 (31.9)	330
413008	95.1 (26.2)	826	180 (35.2)	658	i.d.	i.d.	344 (43)$^{++}$	620
413007	26.2 (11.2)	321	84 (37.8)	398	36 (63.3)	400	146 (56.3)	380
413006	129 (29.7)	352	452 (62.7)	557	47.2 (95.3)	240	628 (78.3)	460
413005	40.6 (8.2)	292	168 (28.7)	593	47.6 (58.4)	480	257 (51.2)	490
413009	34.4 (6.6)	189	87.6(49.8)	264	i.d.	i.d.	152 (50)$^{++}$	210
413004	36.4 (28.5)	303	97.0(26.9)	336	i.d.	i.d.	167 (37)$^{++}$	280

*Base flow loading during events subtracted from total event loading.

**Average concentration is the suspended solids loading divided by the water loading.

$^{+}$95% confidence interval

$^{++}$Loading values are estimated by adding 20% and 30% to Spring and Summer loadings, respectively.

i.d. Data insufficient for determination of loading.

Table I-A-49. Seasonal and annual event unit area loadings* of total P and flow-weighted concentrations** at main stem river stations

STORET number	Spring		Summer		Fall		Annual	
	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L
				1976				
673001	0.072 (0.012)$^{+}$	0.27	0.004 (0.000)	0.55	0.002 (0.000)	0.95	0.077 (0.013)	0.28
683002	0.066 (0.043)	0.08	0.004 (0.000)	0.27	0.000 (0.000)	0.00	0.070 (0.043)	0.08
683001	0.504 (0.112)	0.34	0.030 (0.022)	1.00	0.003 (0.000)	0.43	0.538 (0.114)	0.36
413008	0.457 (0.147)	0.25	0.001 (0.000)	0.08	0.001 (0.000)	0.08	0.459 (0.147)	0.25
413007	0.307 (0.155)	0.35	0.006 (0.000)	0.10	0.004 (0.000)	0.17	0.317 (0.155)	0.34
413006	0.641 (0.482)	0.40	0.119 (0.119)	0.42	0.048 (0.009)	0.53	0.883 (0.484)	0.45
413005	0.459 (0.062)	0.35	0.065 (0.014)	0.93	0.017 (0.005)	0.57	0.541 (0.064)	0.38
413009	i.d.	i.d.	0.161 (0.078)	0.28	i.d.	i.d.	i.d.	i.d.
413004	0.236 (0.068)	0.18	0.018 (0.000)	0.26	i.d.	i.d.	0.271 (0.063)	0.20
				1977				
673001	0.004 (0.004)	0.08	0.105 (0.043)	0.58	i.d.	i.d.	0.136 (0.43)$^{++}$	0.47
683002	0.016 (0.007)	0.10	0.061 (0.011)	0.40	i.d.	i.d.	0.096 (0.012)$^{++}$	0.37
683001	0.085 (0.024)	0.40	0.160 (0.028)	0.85	0.073 (0.60)	.61	0.318 (0.059)	0.61
413008	0.068 (0.022)	0.59	0.134 (0.042)	0.50	i.d.	i.d.	0.252 (0.046)$^{++}$	0.52
413007	0.040 (0.025)	0.49	0.110 (0.054)	0.52	0.031 (0.180)	.34	0.181 (0.079)	0.48
413006	0.282 (0.167)	0.76	0.485 (0.112)	0.60	0.095 (0.180)	.47	0.862 (0.21)	0.63
413005	0.055 (0.013)	0.40	0.211 (0.042)	0.75	0.038 (0.068)	.38	0.304 (0.054)	0.58
413009	0.235 (0.047)	1.30	0.538 (0.449)	1.63	i.d.	i.d.	0.966 (0.451)$^{++}$	1.52
413004	0.050 (0.029)	0.42	0.186 (0.079)	0.64	i.d.	i.d.	0.295 (0.083)$^{++}$	0.58

*Base flow loading during events subtracted from total event loading.

**Average concentration is total P loading divided by water loading

$^{+}$95% confidence interval.

$^{++}$Loading values are estimated by adding 20% to the Spring and Summer loadings.

i.d. Data insufficient for determination of loading.

Table I-A-50. Seasonal and annual event unit area loadings* of soluble P and flow-weighted concentrations** at main stem river stations

STORET number	Spring		Summer		Fall		Annual	
	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L
				1976				
673001	0.044 (0.009)*	0.163	<0.001 (0.001)	0.000	<0.001 (0.001)	<0.001	0.045 (0.009)	0.161
683002	0.052 (0.012)	0.062	0.002 (0.000)	0.200	<0.001 (0.001)	<0.001	0.054 (0.026)	0.063
683001	0.147 (0.008)	0.101	0.008 (0.039)	0.267	0.003 (0.000)	0.030	0.158 (0.031)	0.160
413008	0.119 (0.105)	0.066	<0.001 (0.000)	0.000	<0.001 (0.001)	<0.001	0.119 (0.105)	0.065
413007	0.016 (0.016)	0.018	<0.001 (0.000)	0.000	<0.001 (0.001)	0.001	0.016 (0.016	0.017
413006	0.009 (0.056)	0.006	0.015 (0.021)	0.053	0.009 (0.006)	0.100	0.033 (0.059)	0.017
413005	0.106 (0.017)	0.080	0.005 (0.002)	0.071	0.003 (0.001	0.100	0.113 (0.018)	0.080
413009	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.	i.d.
413004	0.126 (0.029)	0.098	0.007 (0.001)	0.100	i.d.	i.d.	0.138 (0.029)	0.101
				1977				
673001	0.003 (0.003)	0.060	0.045 (0.014)	0.250	i.d.	i.d.	0.060↔ (0.014)	0.209
683002	0.004 (0.001)	0.067	0.016 (0.005)	0.106	i.d.	i.d.	0.025↔ (0.005)	0.095
683001	0.035 (0.016)	0.167	0.040 (0.007)	0.210	0.010 (0.012)	0.083	0.110 (0.015)	0.211
413008	0.002 (0.001)	0.017	0.010 (0.003)	0.037	i.d	i.d.	0.015 (0.003)	0.031
413007	0.005 (0.008)	0.062	0.008 (0.004)	0.038	0.009 (0.006)	0.100	0.022 (0.009)	0.058
413006	0.025 (0.014)	0.068	0.033 (0.011)	0.041	0.014 (0.018)	0.070	0.070 (0.019)	0.051
413005	0.009 (0.002)	0.064	0.012 (0.003)	0.043	0.008 (0.006)	0.080	0.030 (0.005)	0.058
413009	0.052 (0.004)	0.289	0.102 (0.068)	0.309	i.d.	i.d.	0.192↔ (0.069)	0.298
413004	0.009 0	0.076	0.020 (0.004)	0.069	i.d.	i.d.	0.036 (0.006)	0.070

*Base flow loading during events subtracted from total event loading.
**Average concentration is soluble P loading divided by event water loading.
*95% confidence interval.
↔Loading values are estimated by adding 20% to Spring and Summer loadings.
i.d.Data insufficient for determination of loading.

Table 1-A-51. Seasonal event unit area loadings* of lead and flow-weighted average concentrations** at main stem river stations

STORET number	Spring		Summer		Total	
	Loading, kg/ha	Concentration, mg/L	Loading, kg/ha	Concentration, mg/L	Loading kg/ha	Concentration, mg/L
			1975			
413005			0.168 (0.808)	0.420	0.410 (0.262)	0.275
			1976			
413006	0.289 (.484)+	0.182	0.101 (0.659)	0.361	0.416 (1.288)	0.212
413005	0.125 (.213)	0.095			0.132 (0.228)	0.093
			1977			
673001			0.001 (0.002)	0.022	0.008 (0.002)	0.024
683002			0.003 (0.001)	0.020	0.007 (0.001)	0.023
693001			0.007 (0.002)	0.037	0.022 (0.009)	0.042
413007			0.075 (0.135)	0.357	0.124 (0.262)	0.326
413006			0.378 (0.314)	0.467	0.524 (0.504)	0.380
413005			0.063 (0.045)	0.225	0.114 (0.093)	0.219

*Base flow loadings during events subtracted from total event loading.

**Average concentration is the lead loading divided by the water loading.

+95% confidence interval.

Blank means no data.

Table I-A-52. Seasonal and annual event unit water (m^3/ha) and parameter loadings (kg/ha) for areas adjacent to Pilgrim Rd. (683001)*, 124th St. (683001)*, 70th St. (413005)* and Falk Corporation (413004)*

STORET number**	1975				1976				1977			
	Spring	Summer	Fall	Annual	Spring	Summer	Fall	Annual	Spring	Summer	Fall	Annual
							Water					
683002	1,130	386	165	1,488	1,516	10	4	1,548	72	114	i.d.	267
683001	1,058	499	130	1,687	2,256	56	19	2,323	408	242	279	811
413005	2,901	940	***	3,742	532	172	107	798	***	360	95	21
413004	i.d.	i.d.	i.d.	i.d.	849	70	i.d.	478	***	436	i.d.	1,556
							Suspended Solids					
683002	50.9	92.2	12.5	156	65.0	3.3	0.1	68	14.5	69.5	i.d.	107
683001	73.1	108	1.0	180	256	11.8	1.0	332	93.4	136	106	320
413005	***	608	3.1	268	***	95.2	14.9	85.9	***	407	136	359
413004	i.d.	i.d.	***	i.d.	795	***	i.d.	349	***	***	i.d.	***
							Total P					
683002					0.059	0.004	0.000	0.062	0.030	0.009	i.d.	0.050
683001					1.08	0.064	0.007	1.16	0.176	0.291	0.169	0.661
413005					0.470	0.330	0.090	0.710	***	0.450	***	0.070
413004					***	***	i.d.	***	***	***	i.d.	0.163
							Soluble P					
683002					0.060	0.004	i.d.	0.065	0.005	***	i.d.	***
683001					0.273	0.016	0.007	0.360	0.076	0.072	0.023	0.222
413005					0.110	***	0.010	0.108	***	***	i.d.	***
413004					0.420	0.036	i.d.	0.505	0.009	0.137	0.010	0.124

*Adjacent area unit loading is determined by subtracting total loading(s) of upstream station(s) from total loading of a downstream station within the same tributary area and dividing the difference by the area adjacent to that station (e.g., sum of total loadings at 683001, 413008, 413007 and 413006 subtracted from total loading at 413005).

**Unit loadings for stations without upstream stations are presented in Tables I-A-47 to I-A-50.

***Large variances in the estimate of loadings produced negative adjacent area unit loadings. For example, total loadings at 413005 were, in some cases, similar or less than the sum of total loading estimates at four stations above it.

i.d. Date insufficient for determination of loading.

Table I-A-53. Loadings and relative contributions from nonpoint and point sources of pollution for suspended sediment and total P at 70th St. (413005)

Category	1975		1976	
	Nonpoint	Point	Nonpoint	Point
Loadings				
Water, m^3/yr	47,981,000	4,674,000	45,727,000	4,106,000
Total suspended solids, kg/yr	9,274,200	90,500	8,726,700	78,000
Total P, kg/yr			17,400	7,400
Relative contribution, %				
Water	59	6	56	5
Total suspended solids	73	0.7	91	0.8
Total P	62	38	65	28

Table I-A-54. Seasonal and annual total[*] loadings of water at main stem river stations

STORET[**] number	Spring		Summer		Fall		Annual	
	Total, $m^3 \times 10^3$	Event,[*] %	Total, $m^3 \times 10^3$	Event, %	Total, $m^3 \times 10^3$	Event, %	Total, $m^3 \times 10^3$	Event, %
					1975			
673001	5,677	33	2,229	18	1,620	29	9,526	29
683002	14,482	39	5,131	38	3,247	35	22,860	38
683001	20,938	60	9,850	53	5,857	35	36,645	54
413008	8,433	60	3,238	56	1,792	53	13,463	58
413007	5,525	21	2,902	48	907	44	9,334	32
413006	2,648	59	2,032	40	984	60	5,664	53
413005	47,688	66	23,246	56	10,588	32	81,522	59
413004	i.d.	i.d.	i.d.	i.d.	12,481	32	i.d.	i.d.
					1976			
673001	10,581	12	996	6	459	2	12,036	11
683002	18,893	32	1,314	10	691	3	20,988	36
683001	38,775	58	2,747	18	1,326	8	42,848	54
413008	13,973	67	727	9	243	25	14,943	63
413007	7,238	59	1,088	28	409	28	8,735	54
413006	5,879	75	1,359	57	572	43	7,810	70
413005	69,930	61	8,101	30	3,676	23	81,707	56
413004	75,246	59	9,832	26	i.d.	i.d.	85,380	54
					1977			
673001	2,316	10	3,081	28	i.d.	i.d.	7,710[**]	18
683002	3,165	18	4,336	31	i.d.	i.d.	10,712[**]	21
683001	7,710	43	8,294	35	8,243	23	24,238	33
413008	1,465	41	2,338	60	i.d.	i.d.	5,433[**]	46
413007	1,177	36	1,977	53	1,202	35	4,356	43
413006	1,753	58	3,245	70	971	57	5,969	64
413005	12,445	36	19,063	48	13,539	24	45,047	37
413004	14,447	29	21,958	45	i.d.	i.d.	52,007[**]	34

[*] Total represents base flow and event loadings.
[**] 413009 had event loadings only.
[*] Portion of total loading due to event.
[**] Loading values are estimated by adding 30% to the sum of Spring and Summer loadings.
i.d. Data insufficient for determination of loading.

Table I-A-55. Seasonal and annual total*loadings of suspended solids at main stem river stations

STORET** number	Spring		Summer		Fall		Annual	
	Total, kg x 10^3	Event,$^+$ %	Total, kg x 10^3	Event, %	Total, kg x 10^3	Event, %	Total, kg x 10^3	Event, %
					1975			
673001	253	69	88	20	64	15	405	50
683002	502	75	505	77	99	60	1.106	75
683001	1,115	78	1,534	72	146	45	2,649	76
413008	1,310	94	1,178	93	332	72	2,820	91
413007	1,858	76	934	95	23	60	2,815	82
413006	930	86	535	76	133	96	1,598	83
413005	4,364	94	7,563	62	632	73	12,559	72
413004	i.d.	i.d.	i.d.	i.d.	489	93	i.d.	i.d.
					1976			
673001	246	25	33	3	23	1	302	20
683002	600	54	41	34	19	5	660	51
683001	2,427	86	172	54	27	23	2,626	84
413008	2,577	93	571	52	13	55	3,161	86
413007	769	86	224	84	75	49	1,068	83
413006	2,440	95	242	88	37	75	2,719	94
413005	7,973	93	1,390	83	183	74	9,546	91
413004	9,484	96	485	71	i.d.	i.d.	i.d.	i.d.
					1977			
673001	70	11	180	36	i.d.	i.d.	312^{++}	26
683002	91	72	435	79	i.d.	i.d.	657^{++}	78
683001	833	82	1,742	71	1192	59	3,767	70
413008	508	97	971	96	i.d.	i.d.	1,848^{++}	96
413007	208	63	403	93	201	89	812	89
413006	415	86	1,793	97	145	90	1,853	94
413005	1,418	92	5,900	92	1,941	79	9,259	89
413004	1,485	84	4,006	83	i.d.	i.d.	6,863^{++}	84

*Total represents base flow and event loadings.
**413009 had event loadings only.
$^+$Portion of total loading due to event
$^{++}$Loading values are estimated by adding 20% to sum of Spring and Summer loading values.
i.d. Data insufficient for determination of loading.

Table I-A-56. Seasonal and annual total* loadings of total P at main stem river stations

STORET** number	Spring		Summer		Fall		Annual	
	Total, kg	Event,+ %	Total, kg	Event, %	Total, kg	Event, %	Total, kg	Event, %
				1976				
673001	1,565	22	343	6	86	11	1,994	18
683002	2,375	24	308	11	158	0	2,841	22
683001	11,080	70	1,947	24	1,576	3	13,029	64
413008	2,501	94	57	9	26	20	2,584	92
413007	1,814	84	79	38	55	36	1,948	81
413006	2,023	88	626	53	178	75	2,827	87
413005	21,124	70	3,767	56	1,739	31	26,630	65
413004	16,060	51	1,788	35	342	99	18,190	51
				1977				
673001	506	4	1,307	38	i.d.	i.d.	2,266++	29
683002	449	31	1,381	39	i.d.	i.d.	2,287++	37
683001	3,848	35	5,223	47	3,630	31	12,701	39
413008	407	86	779	89	i.d.	i.d.	1,482++	88
413007	333	60	676	81	253	61	1,262	71
413006	918	85	1,664	82	665	40	2,710	89
413005	4,154	43	9,918	68	3,965	31	18,028	54
413004	5,536	31	9,629	68	i.d.	i.d.	18,956++	54

*Total represents base flow and event loadings.

**413009 had event loadings only.

+Portion of total loading due to event

++Loading values are estimated by adding 20% to the sum of Spring and Summer loadings.

i.d. Data insufficient for determination of loading.

Table I-A-57. Seasonal and annual total* loadings of soluble P at main stem river stations

STORET** number	Spring		Summer		Fall		Annual	
	Total, kg	Event,+ %	Total, kg	Event, %	Total, kg	Event, %	Total, kg	Event, %
					1976			
673001	907	23	76	<1	14	<1	998	22
683002	1,434	32	1,185	10	18	<1	1,627	29
683001	4,064	56	113	11	1,282	4	6,460	38
413008	1,232	50	5	<1	1	<1	1,237	50
413007	134	59	5	<1	1	<1	139	57
413006	92	27	92	45	47	53	231	40
413005	6,827	50	708	23	805	12	8,430	44
413004	7,290	59	894	27	928	i.d.	9,113	52
					1977			
673001	186	8	582	37	i.d.	i.d.	1,097++	26
683002	176	20	616	23	i.d.	i.d.	1,131++	19
683001	1,499	36	1,746	35	1473	10	4,718	36
413008	15	67	62	83	i.d.	i.d.	110++	70
413007	45	56	74	53	i.d.	i.d.	170++	64
413006	111	63	111	83	62	63	284	69
413005	773	38	1,803	21	1,213	21	2,789	25
413004	1,066	29	1,684	41	i.d.	i.d.	3,929++	32

*Total represents base flow and event loadings.

**Station 413009 had event loadings only

+Portion of total loadings due to event.

++Loading values are estimated by adding 30% to sum of Spring and Summer loadings.

i.d. Data insufficient for determined ion of loading.

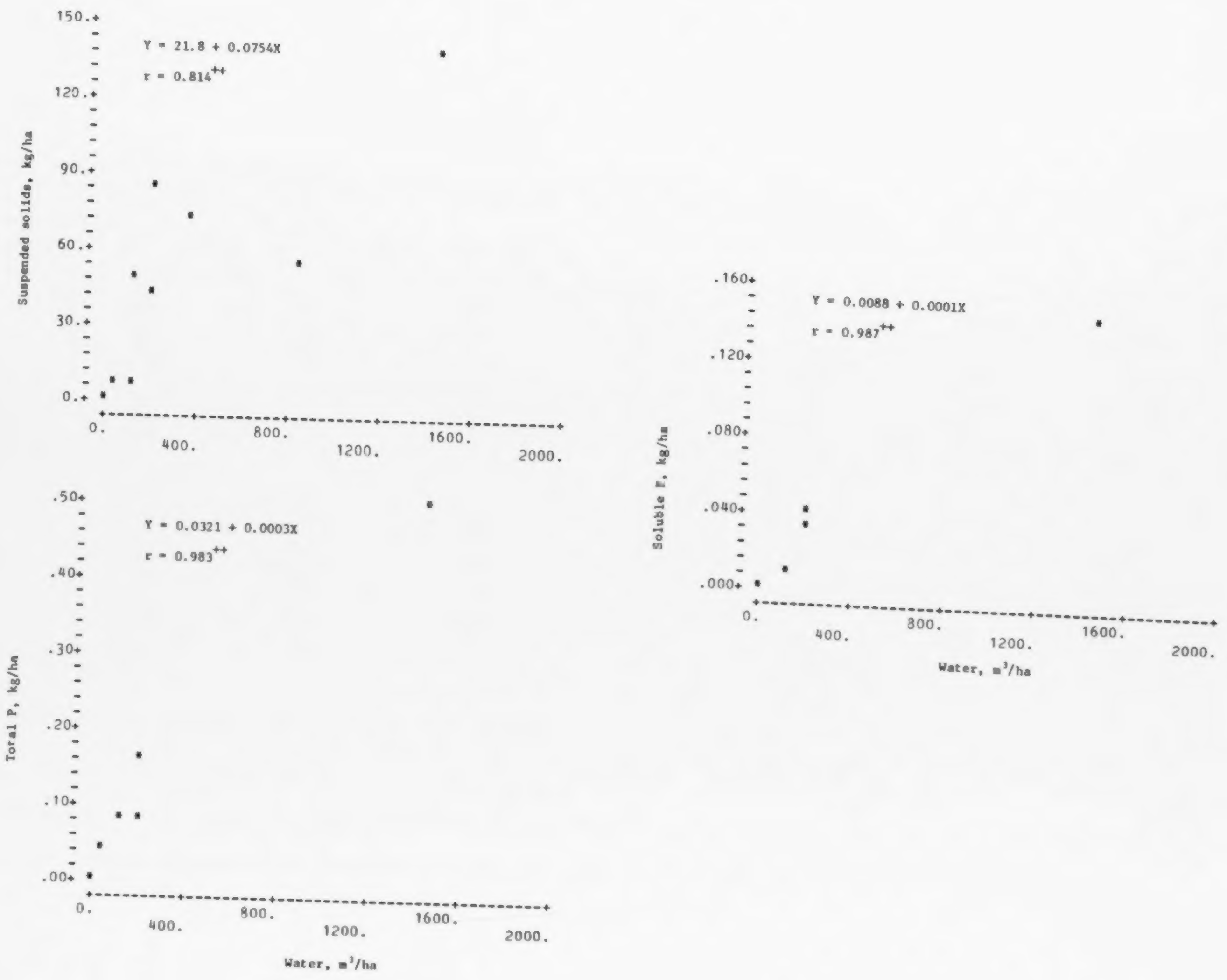


Fig. I-A-24. Relationship of seasonal parameter and water loadings at 124th St. (683001) ($^{++}$Significant at P = 0.01).

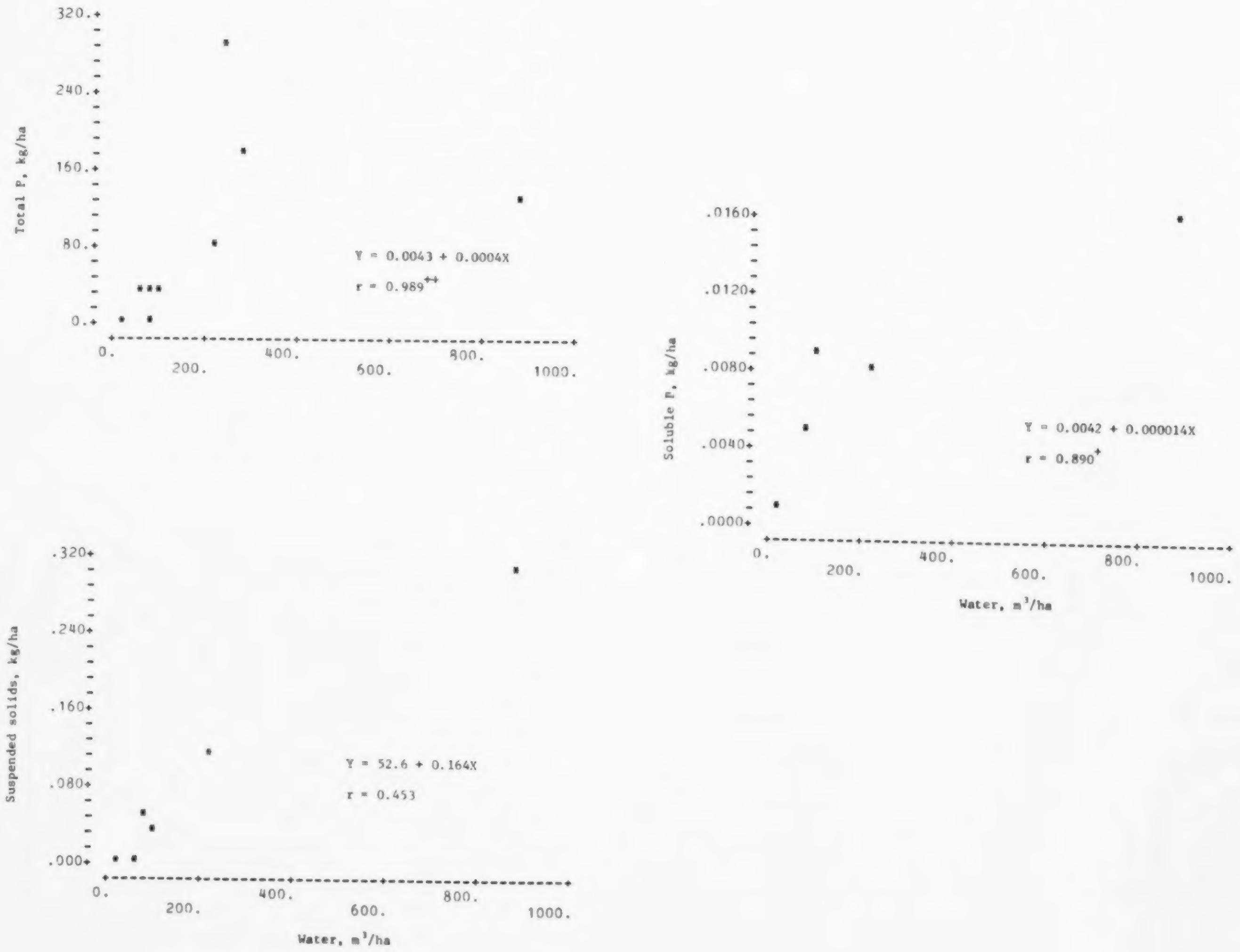


Fig. I-A-25. Relationship of seasonal parameter and water loadings at Underwood Creek (413007) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

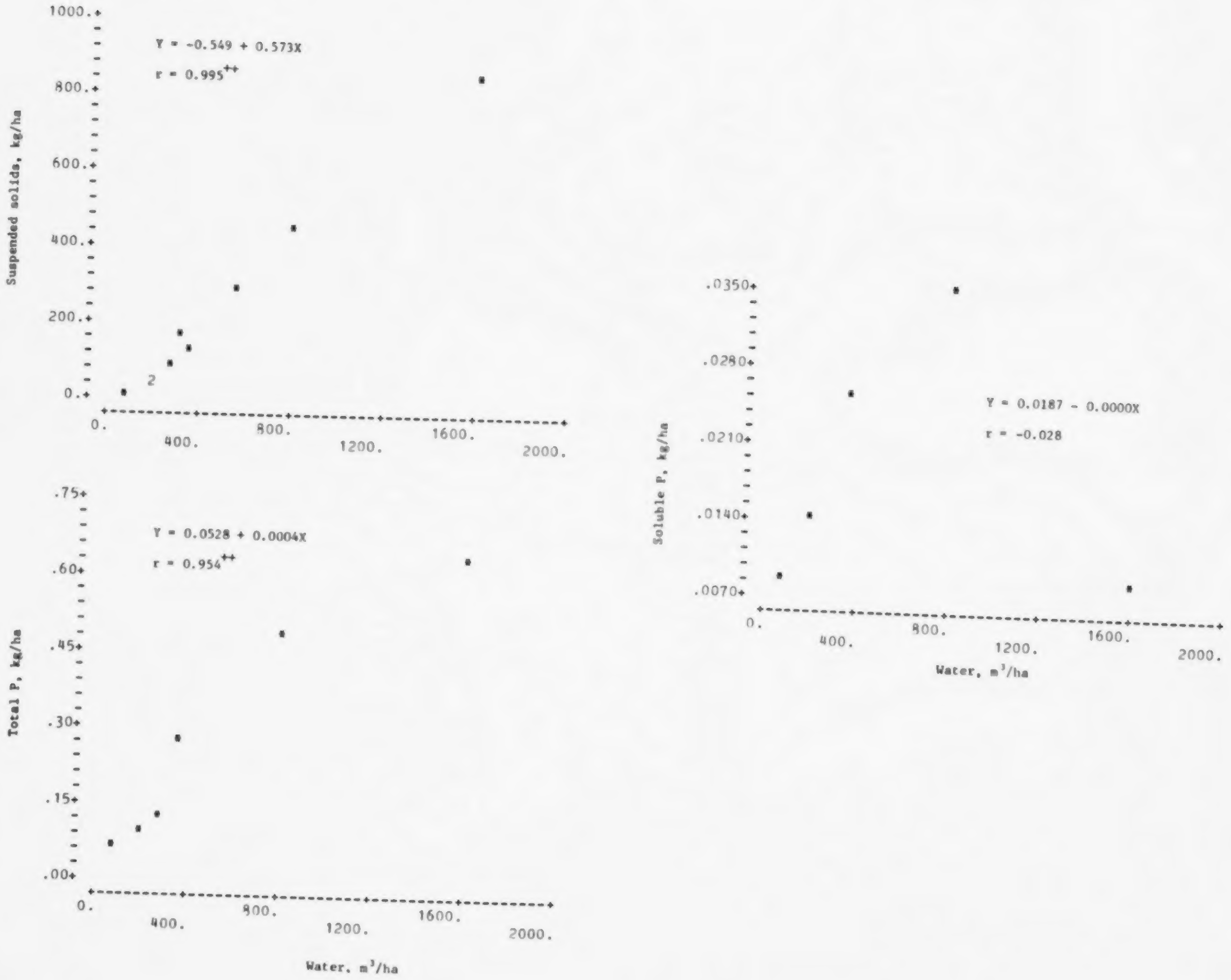


Fig. I-A-26. Relationships of seasonal parameter and water loadings at Honey Creek (413006) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

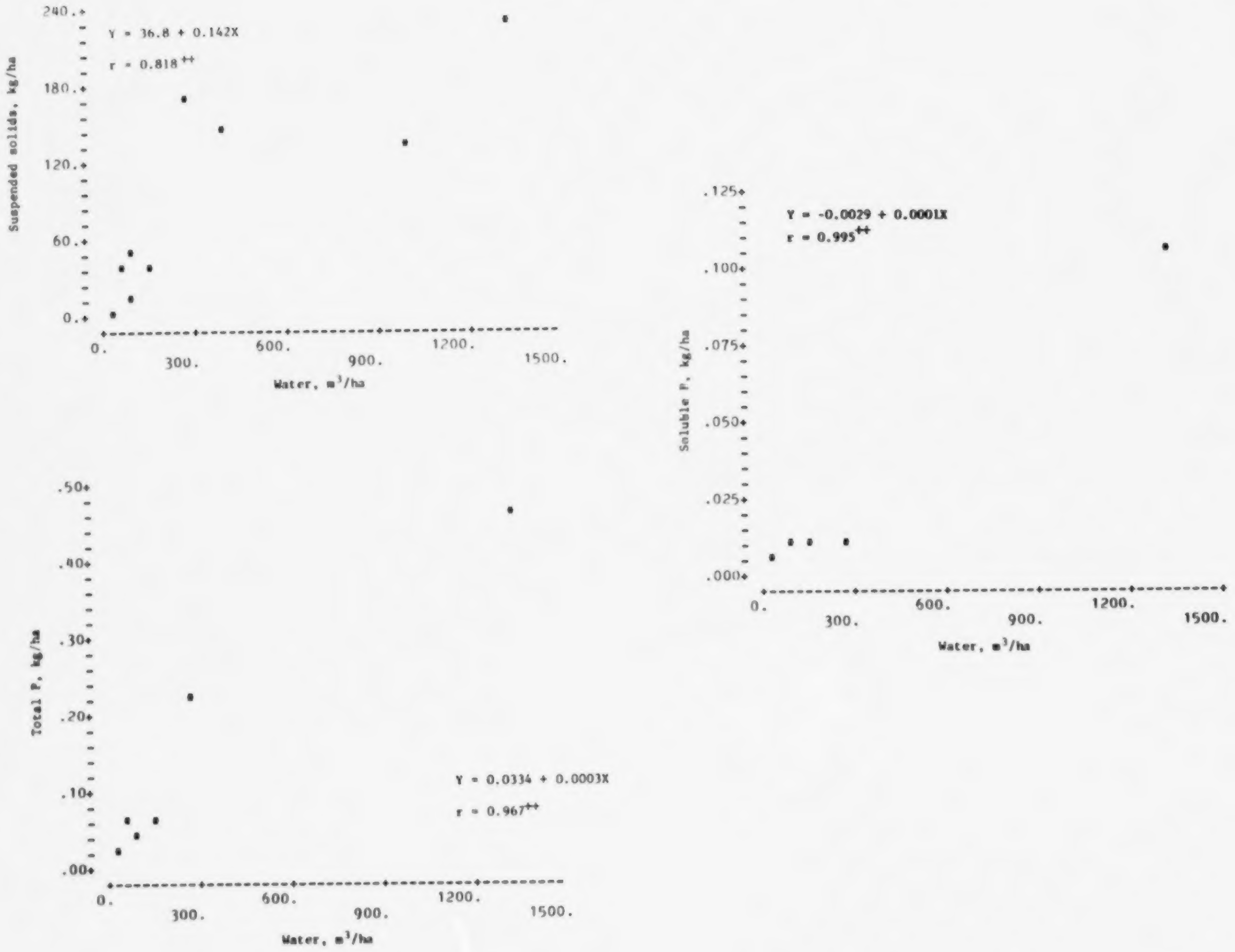


Fig. I-A-27. Relationships of seasonal parameter and water loadings at 70th St. (413005) ($^{++}$Significant at P = 0.01).

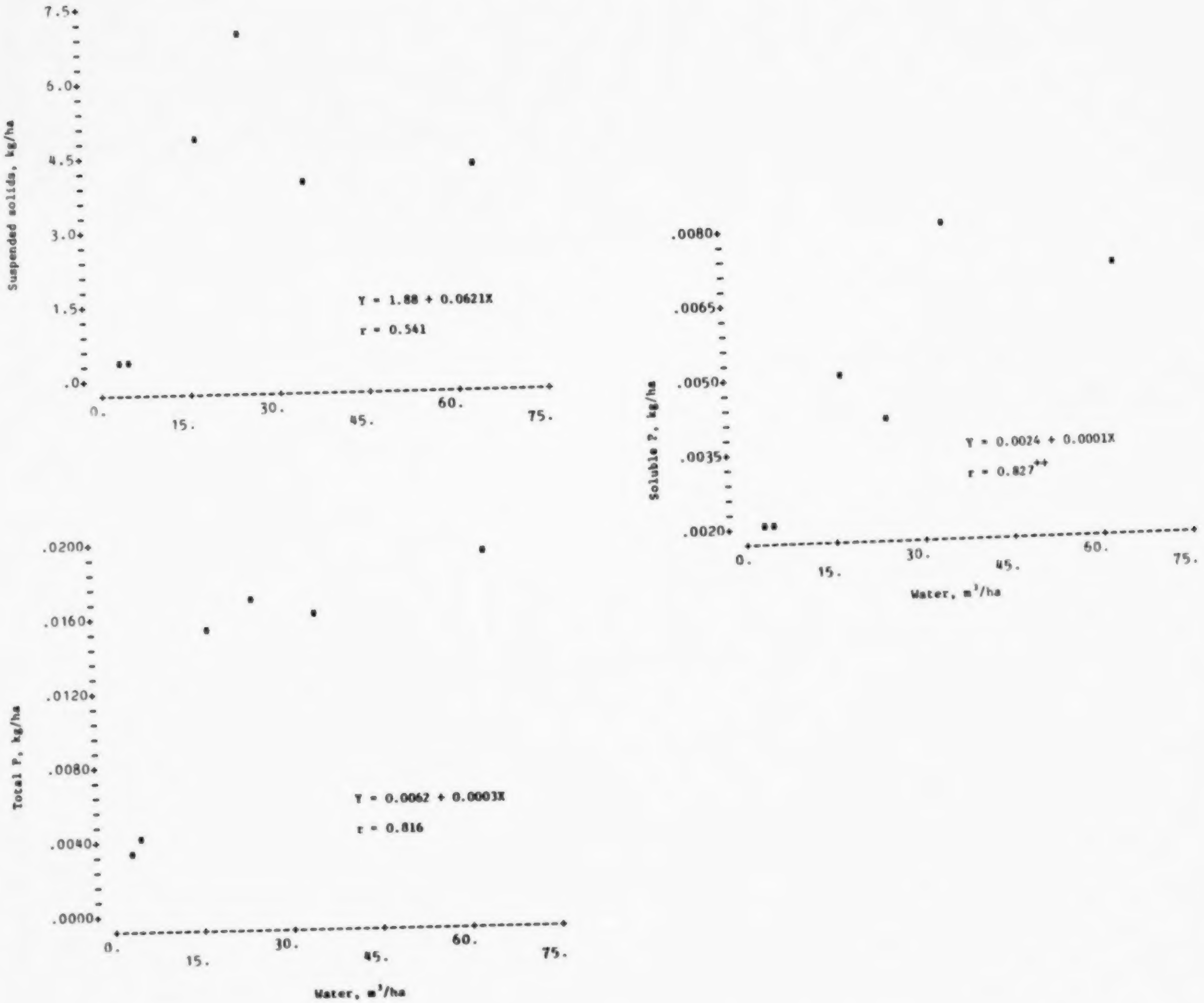


Fig. I-A-28. Relationships of event parameter and water loadings at 124th St. (683001) ($^{++}$Significant at P = 0.01).

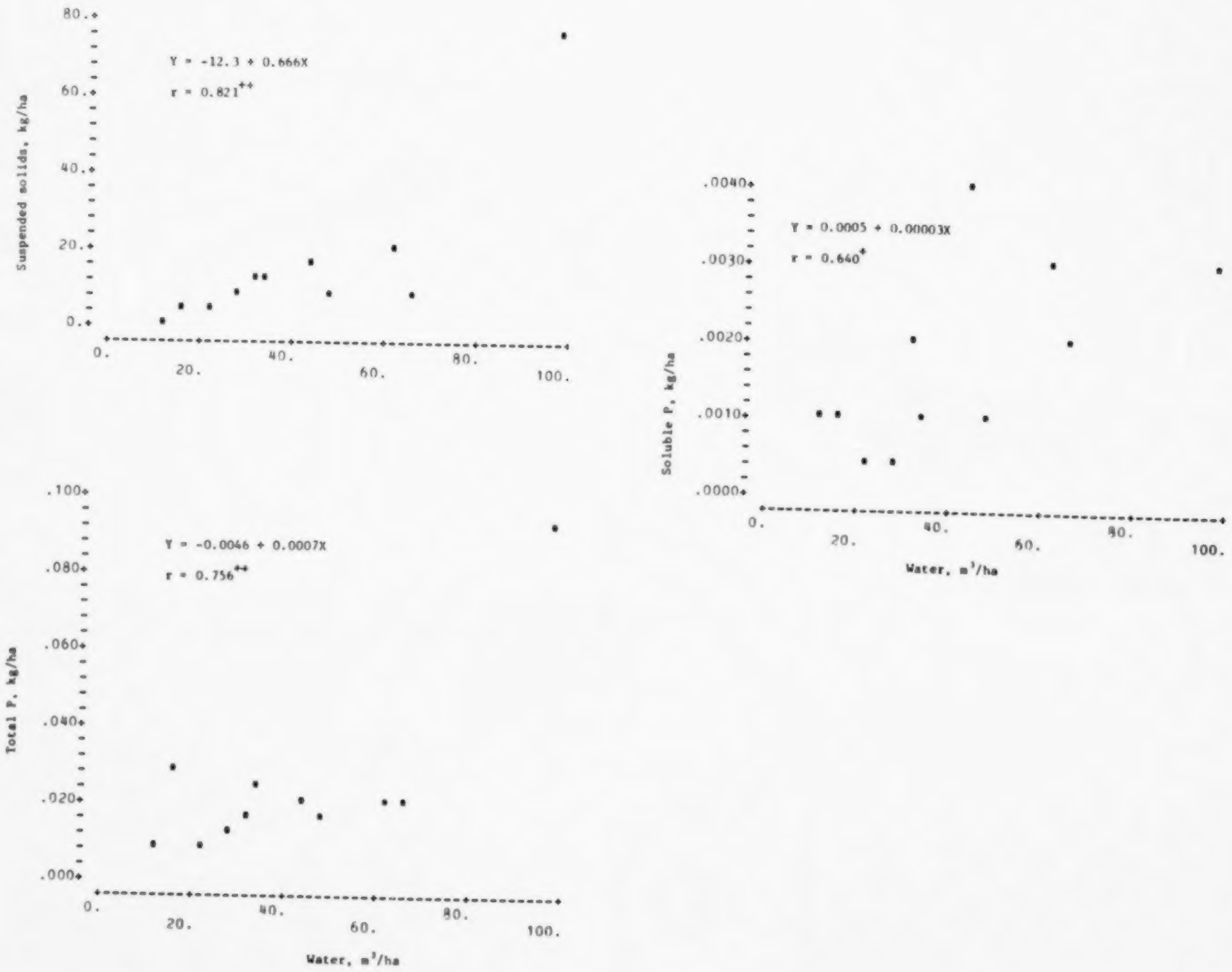


Fig. I-A-29. Relationships of event parameter and water loadings at Honey Creek (413006) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

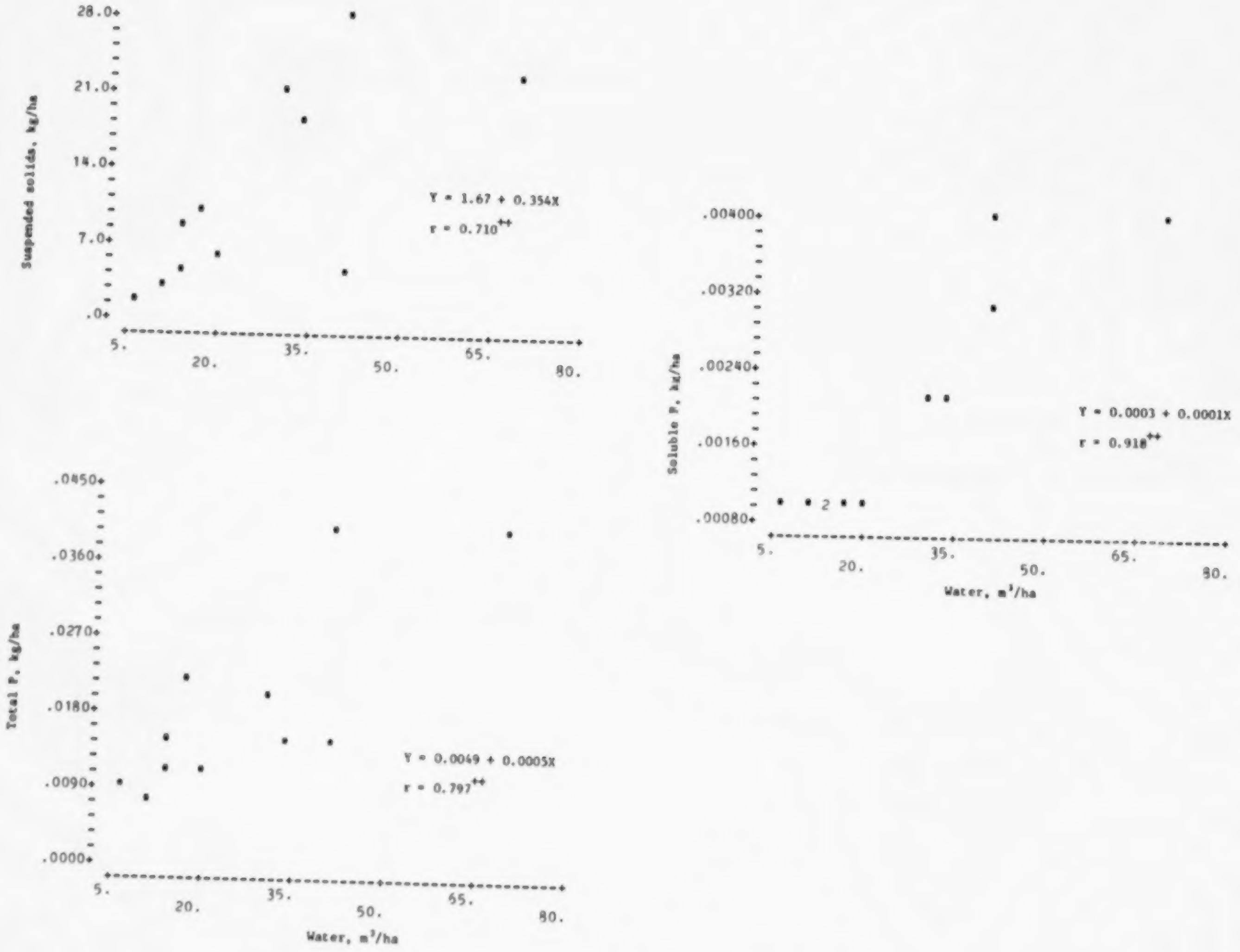


Fig. I-A-30. Relationships of event parameter and water loadings at 70th St. (413005) ($^{++}$Significant at $P = 0.01$).

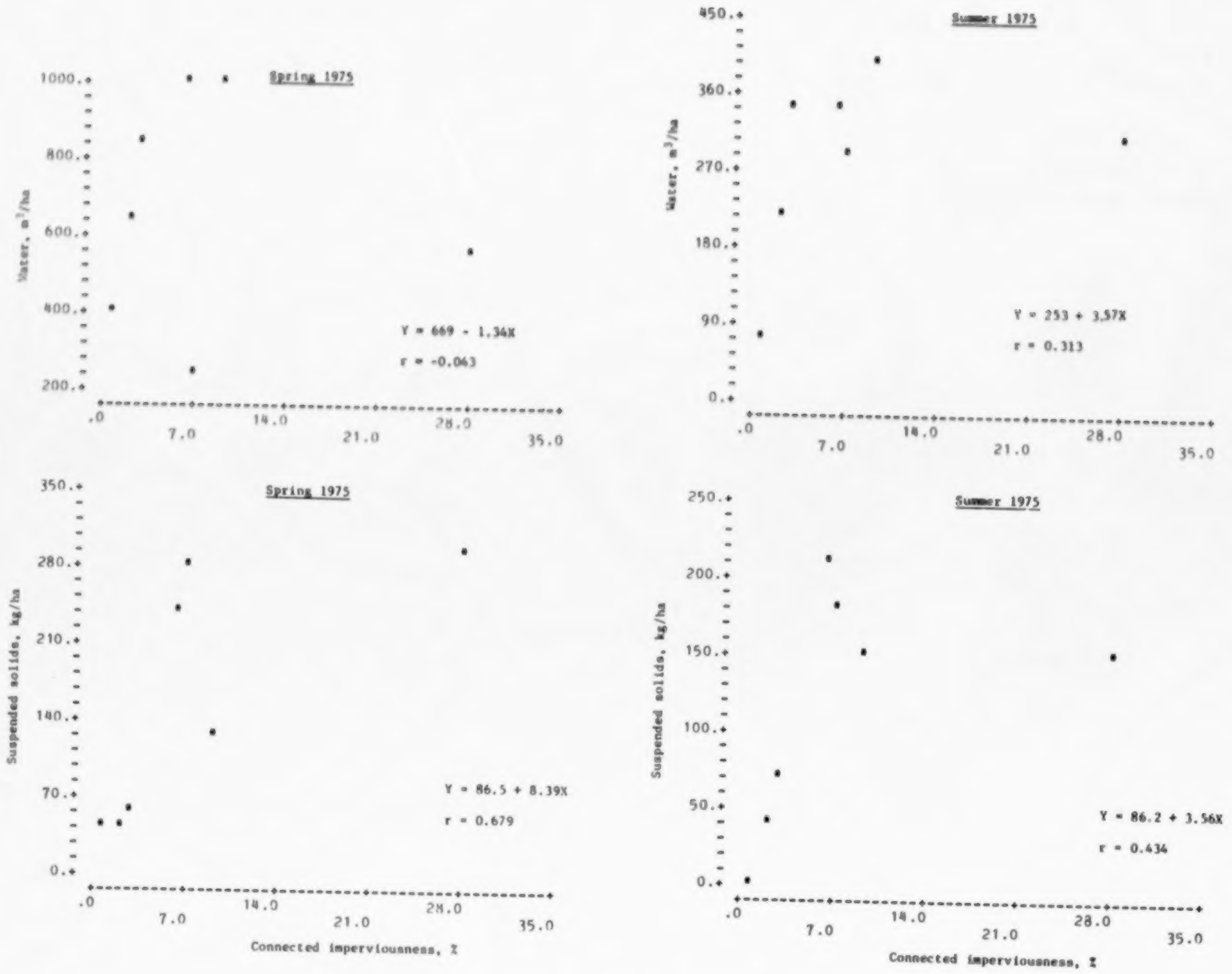


Fig. I-A-31. Relationship of seasonal parameter and water loadings with degree of connected imperviousness during spring and summer 1975.

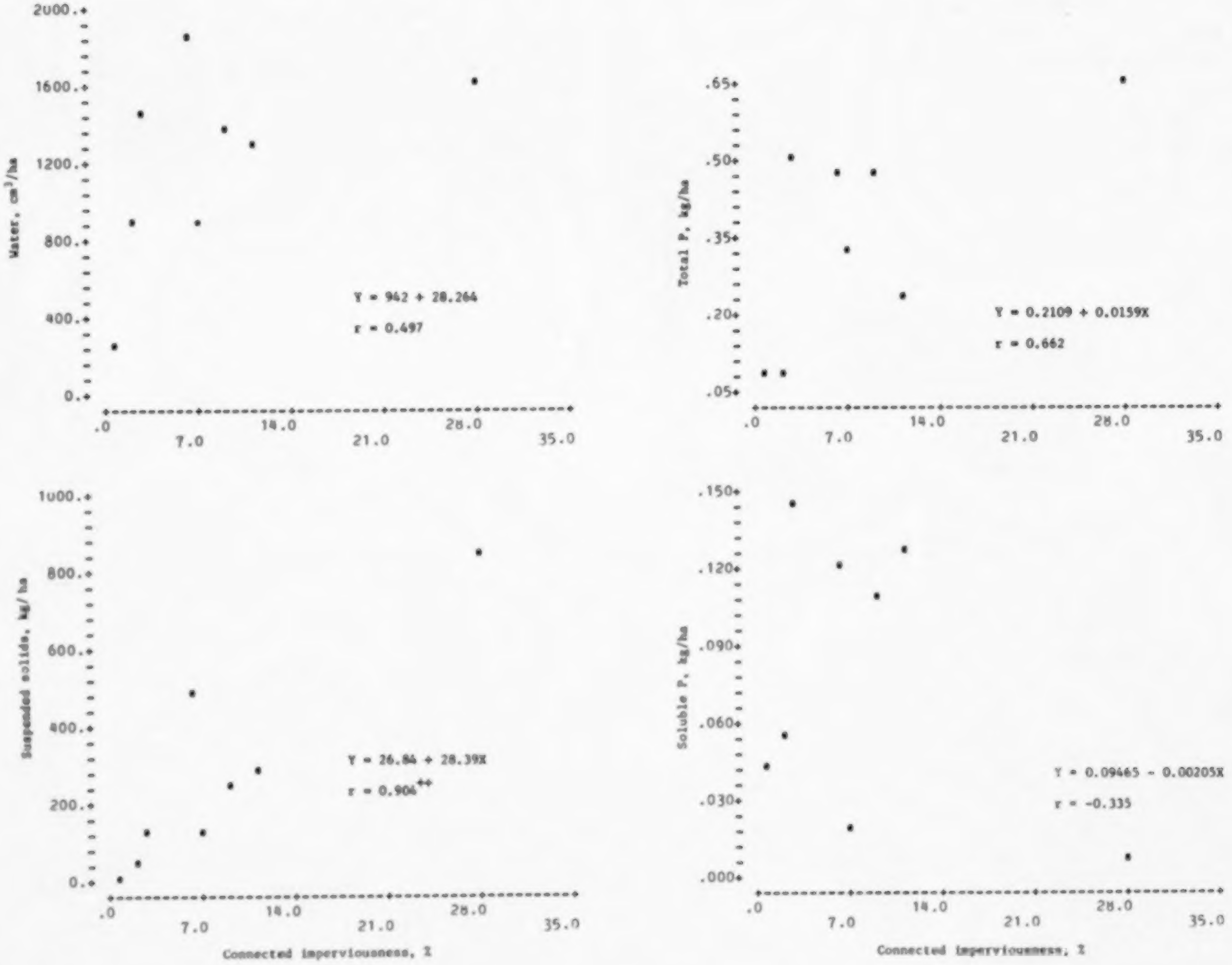


Fig. I-A-32. Relationship of seasonal parameter and water loadings with degree of connected imperviousness during spring 1976 (++Significant at P = 0.01).

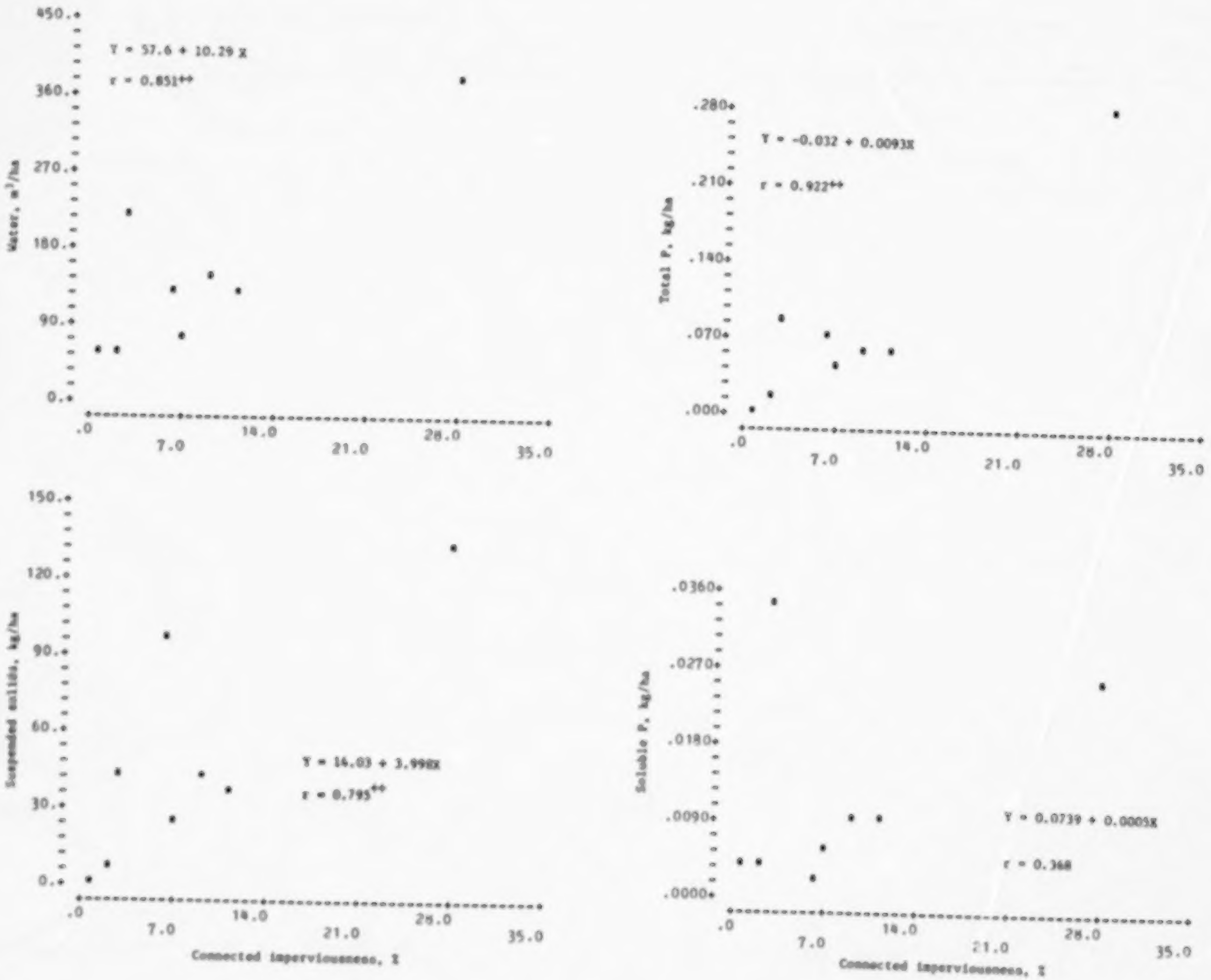


Fig. I-A-33. Relationship of seasonal parameter and water loadings with degree of connected imperviousness during spring 1977 (**Significant at P = 0.01).

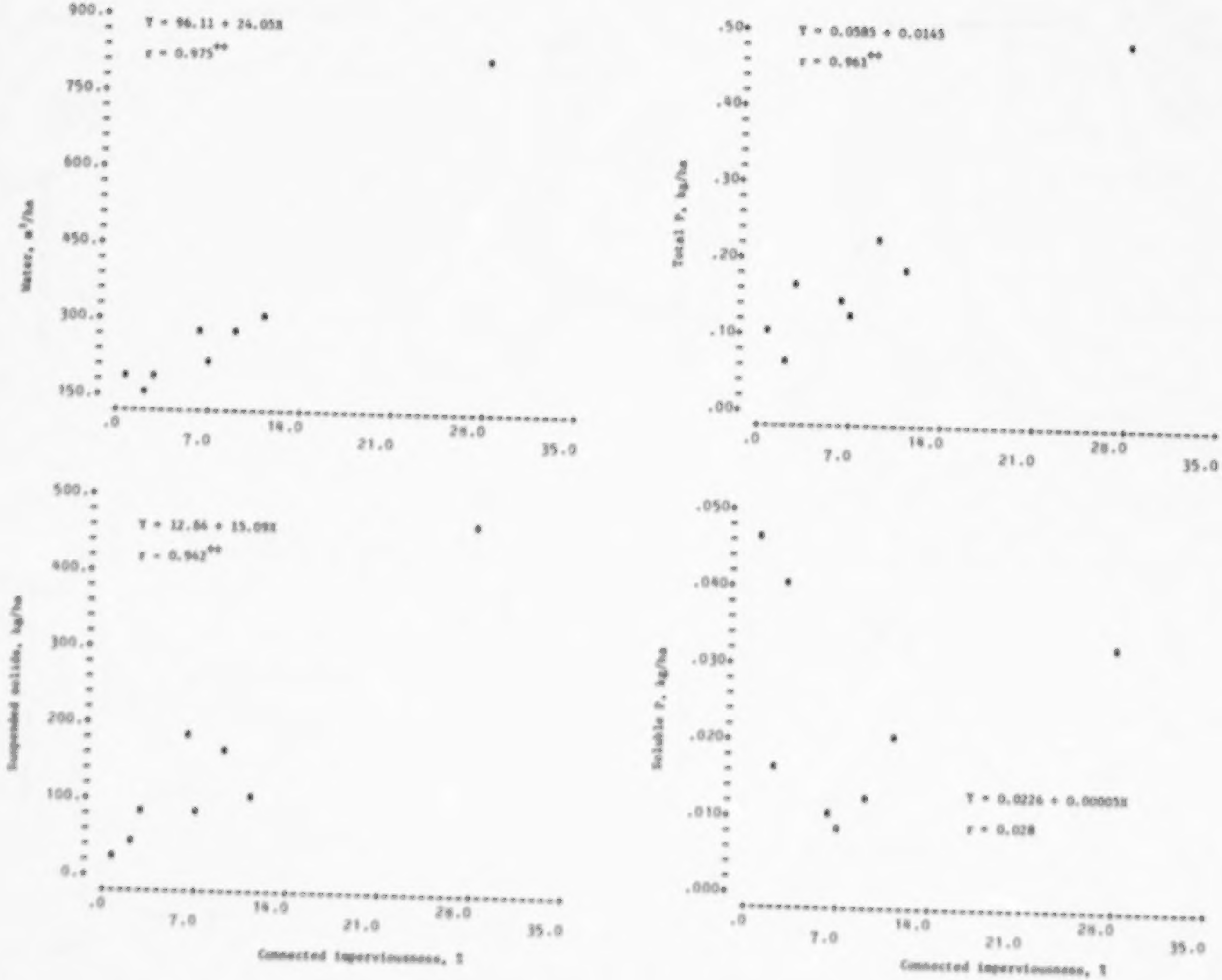


Fig. I-6-36. Relationship of seasonal parameter and water loadings with degree of connected imperviousness during summer 1977 (**Significant at P = 0.01).

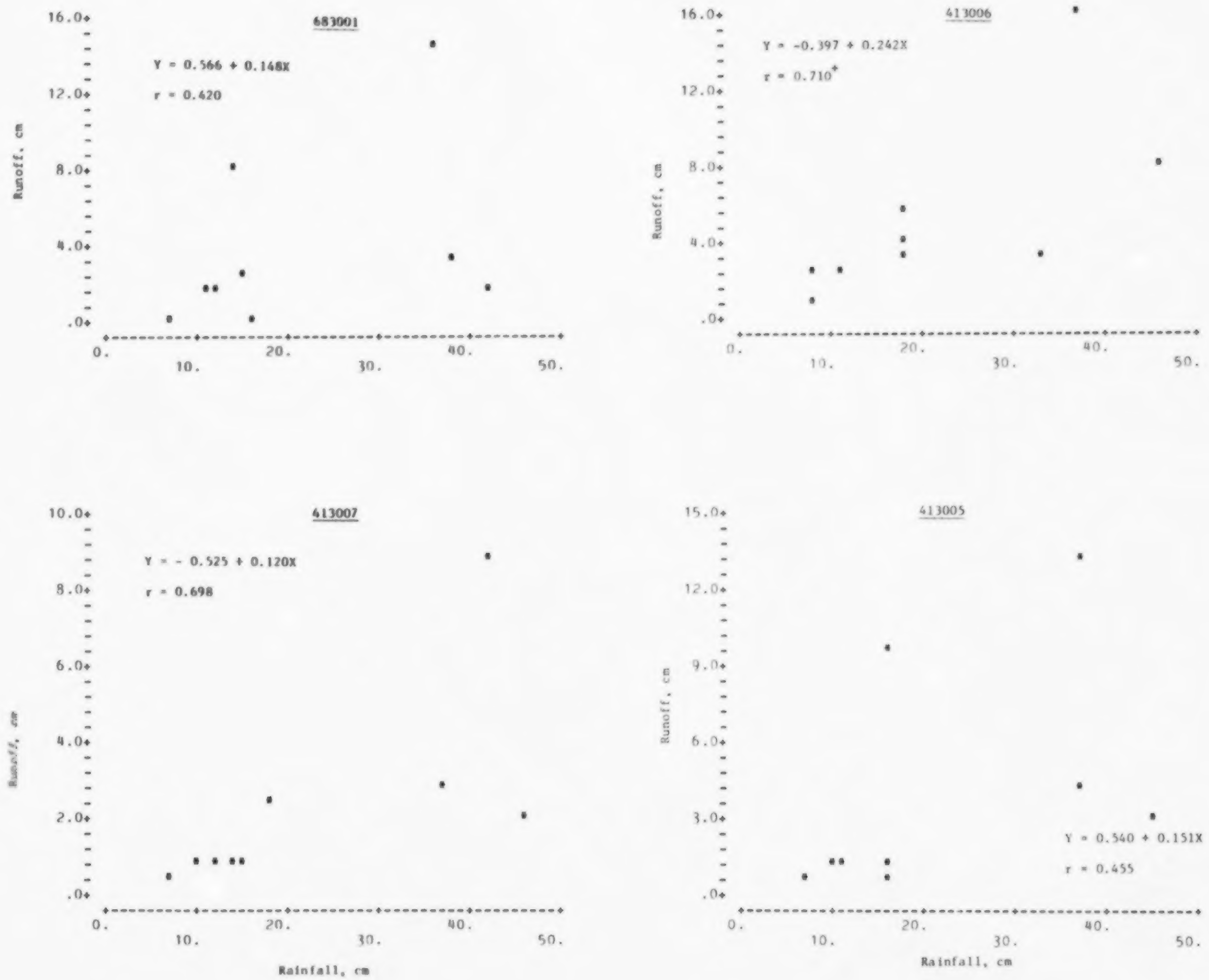


Fig. I-A-35. Relationship of seasonal runoff and rainfall at 124th St. (683001), Underwood Creek (413007), Honey Creek (413006) and 70th St. (413005) ($^+$Significant at P = 0.05).

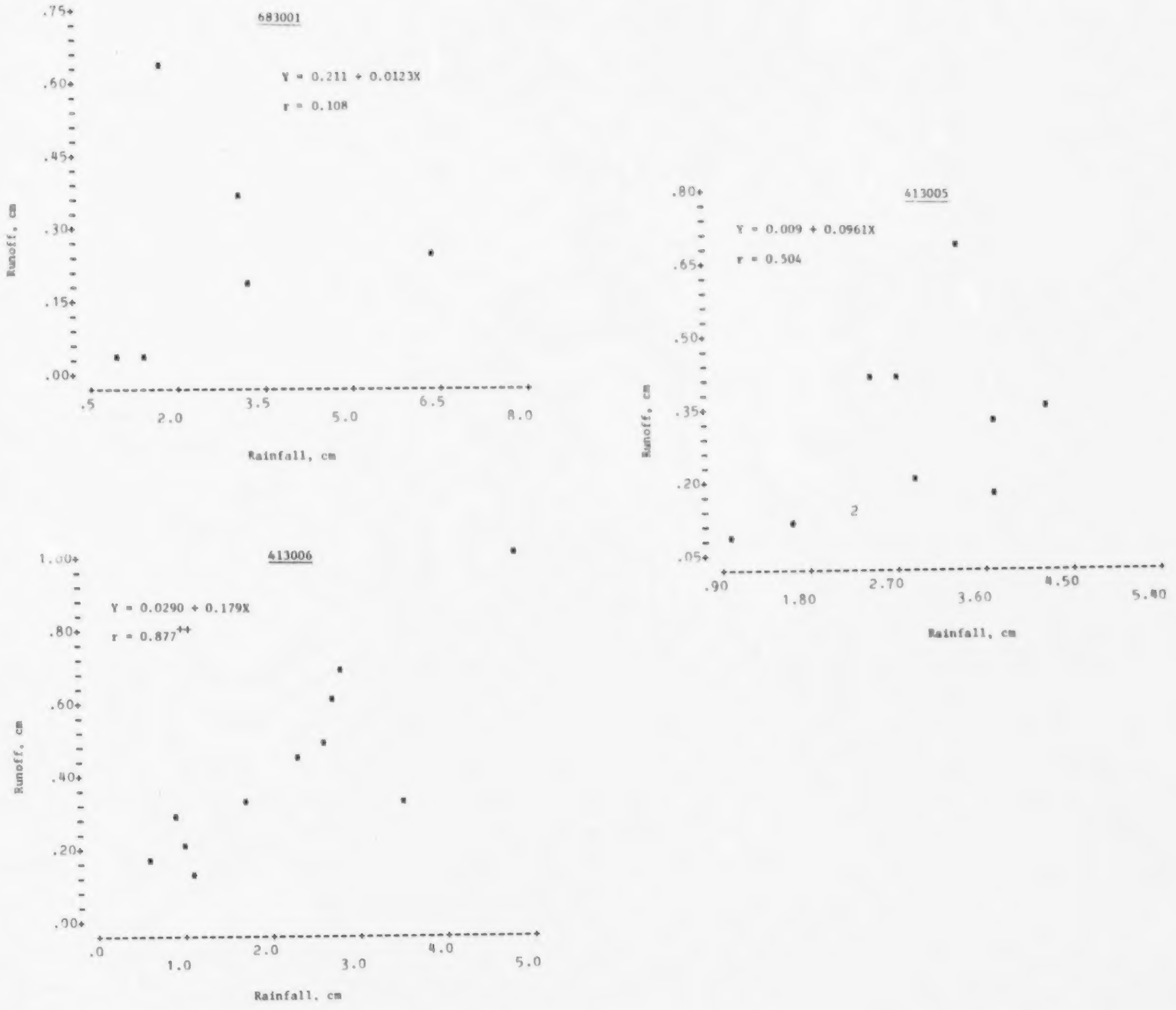


Fig. I-A-36. Relationship of event runoff and rainfall at 124th St. (683001), Honey Creek (413006) and 70th St. (413005) ($^{++}$Significant at P = 0.01).

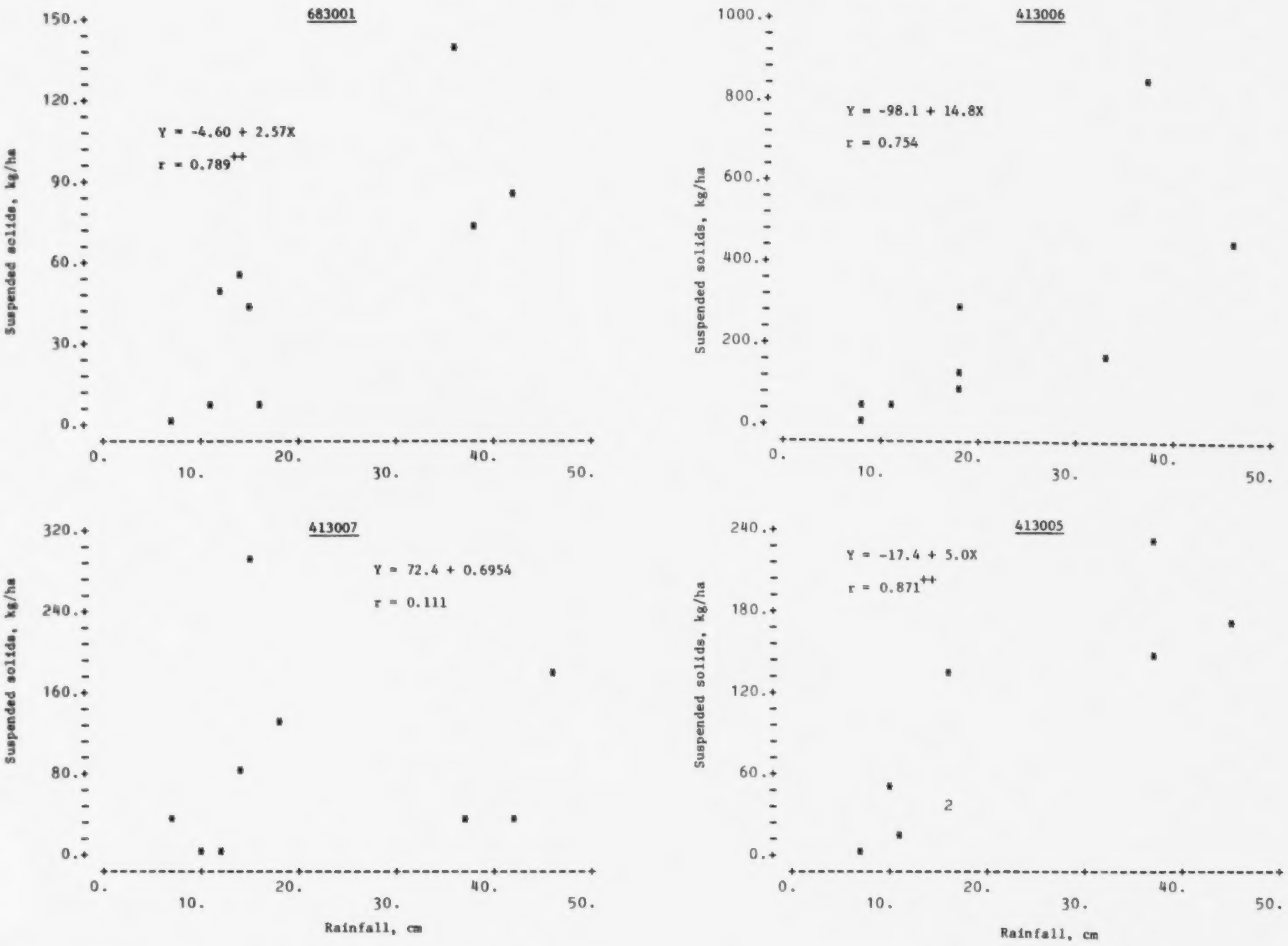


Fig. I-A-37. Relationship of seasonal parameter loadings and rainfall at 124th St. (683001), Underwood Creek (413007), Honey Creek (413006) and 70th St. (413005) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

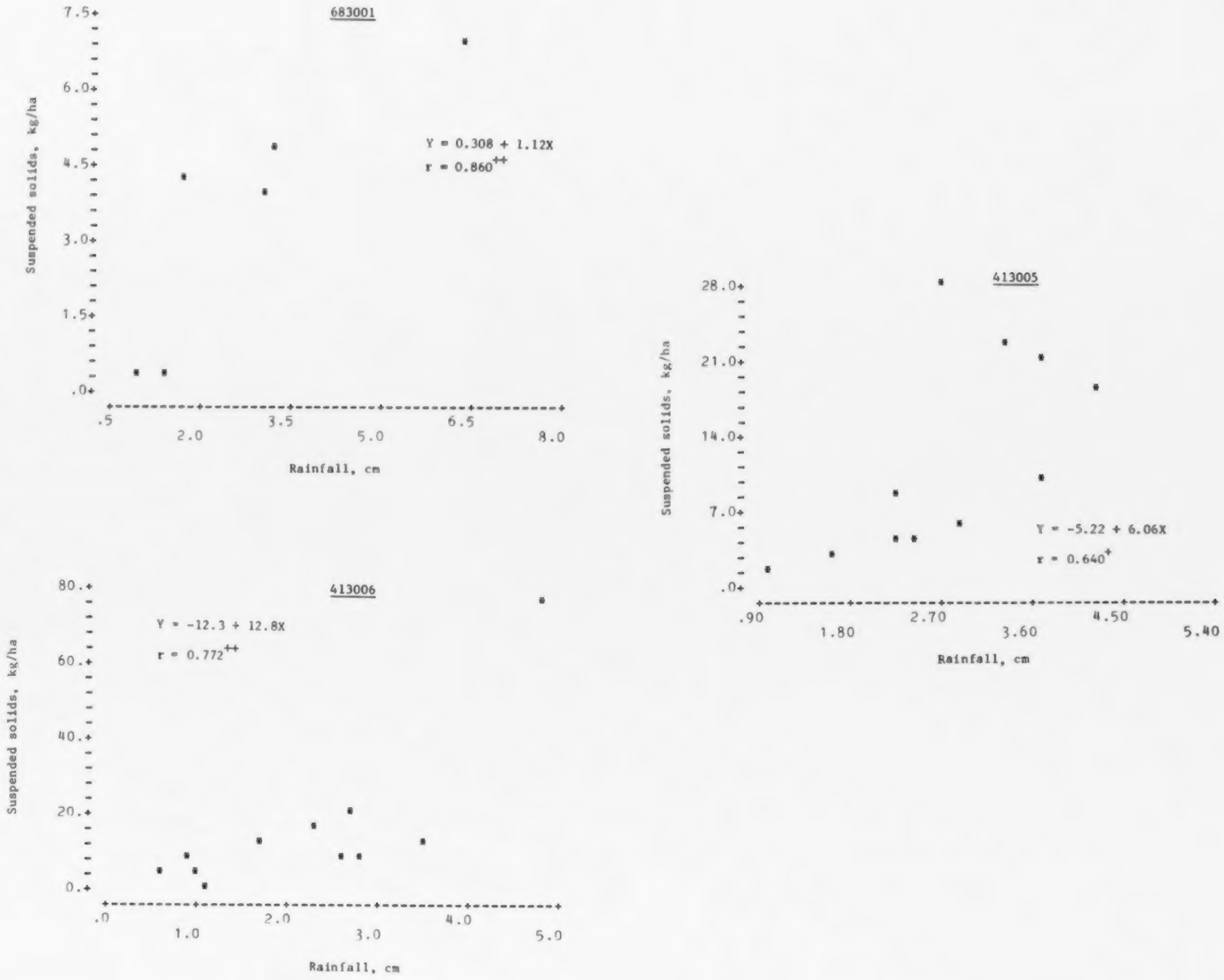


Fig. I-A-38. Relationship of event parameter loadings and rainfall at 124th St. (683001), Honey Creek (413006) and 70th St. (413005) ($^{+}$Significant at $P = 0.05$; $^{++}$significant at $P = 0.01$).

Table I-A-58. Rainfall, runoff and parameter loadings at 124th St (683001), Honey Creek (413006) and 70th St (413005) for selected events

Date	Rainfall, cm	Runoff,* cm	Suspended solids, kg/ha	Total P, kg/ha	Soluble P, kg/ha
			683001		
760505	1.68	0.637	4.3(1.3)**	0.019(0.009)	0.007(0.001)
760928	1.35	0.043	0.4(0.3)	0.004(0.001)	0.002(0.002)
760919	0.89	0.032	0.2(0.03)	0.003(0.000)	0.002(0.000)
770605	3.20	0.171	4.7(1.8)	0.015(0.005)	0.005(0.002)
770718	6.35	0.240	6.8(2.4)	0.017(0.006)	0.004(0.003)
770803	3.10	0.348	4.0(0.7)	0.016(0.001)	0.008(0.001)
			413006		
760515	2.82	0.666	7.9(7.4)	0.019(0.024)	0.002(0.006)
760613	3.45	0.334	12.1(9.0)	0.025(0.191)	0.001(0.001)
760825	0.61	0.165	5.6(2.7)	0.029(0.172)	0.001(0.012)
760828	2.62	0.487	7.4(3.1)	0.016(0.044)	0.001(0.003)
760919	1.12	0.112	1.4(0.5)	0.008(0.014)	0.001(0.008)
770420	1.02	0.210	2.9(0.7)	0.007(0.003)	0.000(0.000)
770604	4.80	0.989	76.5(21.0)	0.092(0.101)	0.003(0.004)
770611	1.65	0.318	12.9(2.2)	0.015(0.014)	0.002(0.004)
770630	2.72	0.615	21.8(4.7)	0.021(0.012)	0.003(0.003)
770805	0.94	0.273	8.1(3.0)	0.013(0.029)	0.000(0.000)
770813	2.24	0.449	15.3(28.4)	0.021(0.021)	0.004(0.004)
			413005		
760505	3.33	0.692	22.1(5.9)	0.04 (0.023)	0.004(0.005)
760515	2.39	0.415	4.4(1.1)	0.015(0.005)	0.004(0.001)
760728	1.02	0.068	1.5(0.6)	0.009(0.011)	0.001(0.005)
760730	3.73	0.170	9.5(2.5)	0.022(0.016)	0.001(0.001)
760828	2.21	0.134	7.7(5.4)	0.015(0.031)	0.001(0.001)
770611	2.74	0.411	28.3(9.0)	0.039(0.018)	0.003(0.001)
770627	1.65	0.106	2.6(0.6)	0.007(0.003)	0.001(0.001)
770630	2.21	0.140	4.5(1.0)	0.010(0.010)	0.001(0.000)
770803	2.84	0.203	5.2(2.2)	0.010(0.005)	0.001(0.000)
770813	3.71	0.309	20.6(21.4)	0.019(0.012)	0.002(0.002)
770828	4.27	0.342	17.8(17.8)	0.015(0.010)	0.002(0.001)

*To convert cm runoff to m^3/ha water load, multiply values by 100.
**( ) 95% confidence interval.

Table I-A-59. Seasonal and annual rainfall and runoff at main stem river stations

STORET number	Spring		Summer		Fall		Annual	
	Rainfall, cm	Runoff, %	Rainfall, cm	Runoff, %	Rainfall, cm	Runoff, %	Rainfall,** cm	Runoff, %
				1975				
673001	12.27	30	42.85	2	9.60	10	73.76	8
683002	12.27	52	40.08	6	10.71	11	72.81	14
683001	14.28	60	37.83	10	10.78	10	73.53	17
413008	15.29	64	39.16	9	12.59	15	78.47	19
413007	18.31	13	36.91	7	11.73	7	80.79	7
413006	18.31	30	33.38	9	10.51	20	74.64	14
413005	16.08	60	36.93	11	11.28	9	75.95	20
413009	18.31	i.d.	32.23	i.d.	11.46	i.d.	75.45	i.d.
413004	16.08	i.d.	36.93	i.d.	11.28	10	75.95	i.d.
				1976				
673001	31.90	8	14.68	0.5	5.51	0.1	55.47	4
683002	33.38	24	16.30	0.8	6.62	0.4	59.67	13
683001	35.67	41	15.50	2	6.50	0.7	60.81	23
413008	34.64	52	16.46	0.8	6.21	2	60.25	30
413007	42.34	20	13.69	4	6.60	3	65.12	15
413006	37.19	42	18.30	15	7.47	12	66.01	29
413005	36.63	36	16.23	5	6.68	3	62.51	22
413009	40.03	14	17.88	8	8.08	7	69.04	11
413004	36.63	35	16.23	4	6.68	i.d.	62.51	i.d.
				1977				
673001	16.97	3	37.85	5	11.02	i.d.	70.67	5***
683002	14.75	5	40.92	3	12.92	i.d.	73.43	4***
683001	14.83	14	41.89	4	11.70	10	73.25	7
413008	16.04	7	46.32	6	10.08	i.d.	77.26	7***
413007	14.71	6	46.30	5	9.68	9	75.52	5
413006	17.72	20	45.61	18	8.40	24	76.25	19
413005	15.85	9	44.48	6	10.22	10	75.07	7
413009	14.58	12	46.51	7	8.33	i.d.	73.96	10***
413004	15.85	8	44.48	6	10.22	i.d.	75.07	8***

*Average of all USGS rain gauges in each tributary area; the historical average precipitation values summarized for long term rain gauging stations in and near the watershed were 5.81, 19.71, 33.60, 14.71 and 73.83 cm for winter, spring, summer, fall and annual, respectively.

**Includes precipitation in winter.

***Annual runoff is estimated by adding 30% to sum of spring and summer runoffs.

i.d.Data insufficient for determination of runoff.

Table I-A-60. Relationships of water and parameter loading during events at selected dates and stations

Parameter	Cumulative load, %									Total*
					413006 (770605)					
Water	10	20	30	40	50	60	70	80	90	105.1
Suspended solids	18	28	33	36	38	50	66	79	89	79,759
Total P	23	34	41	45	48	58	71	82	91	79.2
Soluble P	6	14	27	42	51	57	68	79	88	4.14
					413006 (770805)					
Water	10	20	30	40	50	60	70	80	90	27.3
Suspended solids	25	41	51	58	69	79	87	94	98	7,343
Total P	26	44	56	62	70	78	84	90	96	7.71
Soluble P	7	19	28	36	47	57	66	76	91	0.46
					413005 (770628)					
Water	10	20	30	40	50	60	70	80	90	10.3
Suspended solids	10	21	36	51	67	83	92	96	99	2,293
Total P	23	36	51	66	78	81	85	90	96	4.38
Soluble P	9	12	16	20	27	32	41	56	80	0.509
					413005 (770813)					
Water	10	20	30	40	50	60	70	80	90	26.2
Suspended solids	13	32	50	63	70	80	89	95	98	12,616
Total P	14	30	45	56	63	72	81	89	84	12.45
Soluble P	12	22	31	39	45	55	68	79	88	1.90

*Total parameter load is in g/ha except water load which is in m^3/ha (m^3/ha x 0.01 = cm).

PART II

QUALITY OF RUNOFF FROM PREDOMINANTLY SINGLE LAND USES

by

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ABSTRACT

The quality of runoff from ten predominantly single land use areas (50 to 2,040 ha) were monitored in 1976 and 1977 using automatic flow recording and water sampling instruments. Seasonal flow and concentration data for 26 parameters monitored throughout the study are documented, although discussion is focused on the key parameters--suspended solids, total P, lead and cadmium--to demonstrate seasonal and site differences. Data for bacterial counts and PCB concentrations determined sporadically are also included. Evaluation made on the concentration data includes 1. comparison with water quality criteria, 2. correlation analysis to show interrelationships among parameters and 3. behavior of parameter concentrations and loading rates during an event.

Seasonal unit loadings of 21 parameters estimated by a statistical model enhanced by a ratio estimator are presented. Main hydraulic and land activity factors affecting variations of loadings from location to location are discussed. These factors affect either the amount of runoff generated or the pollutant concentration. Remedial measures should be oriented towards those land use areas (heavy industry, freeway and commercial), which because of their high connected imperviousness, generate high amounts of runoff (loads), and towards curtailing those land activities in land use areas like heavy industrial, freeway, commercial and developing medium density residential areas, which result in high pollutant concentrations.

Other data evaluated are 1. rainfall-runoff relationships and 2. occurrence of first flush.

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II-1. INTRODUCTION

The heterogeneity of land uses in the Menomonee River Watershed precludes the use of most of the river and tributary sampling stations as predominant single land use study sites. Additional monitoring stations were built at the outlets of homogeneous and/or predominant land use areas in the Watershed to define more precisely the quantity and quality of stormwater from these areas. These study sites are representative of the major land uses in the Watershed, and data gathered at the monitoring stations complemented data from the major river and tributary monitoring stations. Data from the predominant land use stations were also used to calibrate the LANDRUN overland flow model described in (1).

II-2. CONCLUSIONS

Considerable fluctuations of flow and parameter concentrations occurred between seasons at a given station and between stations during a season. Flow and parameter concentrations as examplified by the key parameters--suspended solids, total P, lead and cadmium--were high in stations with high connected imperviousness (413616, 413615 and 413010) and low in stations with negligible connected imperviousness (413625 and 683090). There was a dramatic effect of land use type on lead levels; high concentrations observed at the freeway (413615) and heavy industrial (413616) sites and low concentration at the low density residential (413625 and 683090) and agricultural (463001) sites.

Comparison of overall mean parameter concentrations with water quality criteria indicates that the runoff contaminants that are most likely responsible for water quality impairment are lead for domestic water supply; suspended solids and zinc for aquatic life; total P for eutrophication; and fecal coliform for swimming.

Linear correlation analysis of overall parameter concentrations demonstrated significant associations of suspended solids with nutrients (except soluble species) and several metals. This relationship was also observed seasonally for individual stations. Soluble P tended to have a low or inverse relationship with suspended solids. The significant correlations of suspended solids with total P and metals suggest that a management scheme which includes removal of suspended solids from stormwater also reduces associated pollutants.

Bacterial counts increased during events at two medium density residential sites (413011 and 413010) but not at the agricultural site (413001). PCBs were detected sporadically during some events, particularly at the heavy industrial (413616) and freeway (413615) sites.

During events, concentrations of suspended solids, total P and lead increased generally at the rising stage of the hydrograph as increased flow produces simultaneous scouring of particulate materials. Loading rates of the above parameters including soluble P were associated closely with flow and occasionally with concentration. A wide variation in concentrations occurred over the hydrograph which emphasizes the importance of obtaining several samples during runoff to obtain a better representation of the event.

Water and pollutant loadings varied considerably from season to season at each station and from station to station for each season. Seasonal and site differences were accounted mostly by variations in the amount of runoff and, to some extent, by the variation of pollutant concentrations.

In order to devise a hazard-ranking system for homogeneous land use areas, it is imperative to identify factors responsible for accelerated pollutant loadings, namely, hydraulic factors which determine amounts of runoff and land use/activities that affect pollutant concentrations. The main hydraulic factor affecting runoff generation is the connected imperviousness of a specific area. Storm-sewered areas with high connected imperviousness (413616, 413615 and 683089) do not only generate high amounts of runoff but also typically export high pollutant loads. Stations with natural drainage systems and low connected imperviousness (413615 and 683090) have relatively lower runoff and typically generate much lower pollutant loads. Some land use/activity factors are long term which cause either persistently high concentrations, such as high lead values from heavy traffic (413615) and heavy industry (413616) areas or persistently low concentrations such as the apparent increased trapping efficiency for suspended solids and associated pollutants at stations 413625 and 683090. Other factors affecting pollutant concentrations are either temporary or seasonal, notably, construction and salting activities. Remedial measures should be oriented not solely on land use type but rather towards curtailing those short term land activities which result in high pollutant concentrations, and towards those areas, which because of their hydraulic characteristics like high connected imperviousness, generate persistently high pollutant loadings.

Analysis of rainfall-runoff relationship indicates that the amount of runoff was associated closely with rainfall only in areas with high imperviousness. The percentage of runoff did not necessarily increase with the size of rainfall event. The time elapsed since the previous rainfall affected neither runoff nor pollutant loadings.

The occurrence of first flush is apparent particularly in areas with high imperviousness.

II-3. MATERIALS AND PROCEDURES

Study Sites

The predominantly single land use sites were selected to represent most of the major land uses in the Menomonee River Watershed, namely; residential, commercial, industrial, agricultural and freeway. Table II-1 and Fig. II-1 show the land use distribution and imperviousness in the drainage areas for the sites and relative location of the monitoring stations, respectively. For more detailed description of the sites refer to (2).

Sampling Equipment

Each station consisted of a flow control structure, stage recorder, stilling well, automatic water sampler and protective enclosure (Table II-2 and Fig. II-2). Power was provided by either a direct electric line or a 12-volt heavy duty battery.

Sampling stormwater in urban areas poses a problem in that the high percentage of impervious surfaces results in flashy or rapid increase and decrease in discharge. Generally, sampling proportional to flow is unsatisfactory since a fixed water load must be used to actuate the sampler. To partially eliminate this problem, activation of the Instrument Sepcialties Company (ISCO) 1680 sampler and event marker of the Stevens Type A Model 71 stage recorder strip chart was accomplished using an electromechanical system (Fig. II-3). Mounted on the 750 mm circumference float pulley of the stage recorder were fifteen magnets spaced 5 cm apart. As the float pulley rotated, with changing stage, the magnets came to near contact with a mangetic reed switch. The closure of this switch, induced by the magnetic field, activated the ISCO sampler. The system was set up such that at the initial change in stage the ISCO commercial sampling. After this sequence, the sampler oeprated after a set number of pulse counts (magnetic reed switch closures) determined from field observations and the hydraulic characteristics of the drainage area of the site.

During the interval of sampling the ISCO sampler's event signal was used to activate a single pole double throw (SPDT) relay (Fig. II-3). This SPDT relay controlled the event marker push solenoid to which a pen was mounted. For the duration of sampling, an event mark was written on the strip chart. After the sampling was completed the SPDT relay, push solenoid and pen returned to a relaxed position.

Table II-1. Characteristics of the drainage area of the predominantly single land use monitoring stations*

STORET number	Location	Area, ha	Land use** distribution, %														Imperviousness, %	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total	Connected
463001	Donges Bay Road, Mequon	2,144	0	0.75	1.86	0.05	6.95	1.54	1.59	43.8	30.2	9.79	2.28	0.56	0	0.65	4.0	1.0
413010	Schoonmaker Creek at Vliet St.	179	0	4.47	22.3	0.56	65.9	0	1.68	0	5.03	0	0	0	0	0	53.5	32.7
413011	Noyes Creek at 91st St.	552	1.81	15.0	19.7	3.80	30.2	0.18	2.72	0.18	22.8	0.36	0.07	0	2.72	0.36	34.9	28.0
413625	City of New Berlin at 124th St. and Greenfield Ave.	224	0	2.68	11.2	0.89	0	56.7	2.68	0	25.0	0.89	0	0	0	0	22.5	0.30
683090	Village of Elm Grove, ditch at Underwood Pkwy.	166	0	1.81	10.2	0	0	78.9	3.61	0	3.01	2.41	0	0	0	0	24.3	0
413614	Timmerman Airport, manhole #6	140	0	95.7	3.57	0	0	0.71	0	0	0	0	0	0	0	0	18.0	6.6
413615	Stadium interchange, I-94, manhole #120	64	0	14.1	40.6	0	17.2	0	0.16	0	28.1	0	0	0	0	0	44.6	43.2
683089	Brookfield Square Shopping Center	61	0	60.7	4.92	0	8.20	0	0	0	26.2	0	0	0	0	0	50.4	44.9
413034	City of Wauwatosa, off Ferrick St.	110	22.7	49.1	8.18	0	7.27	0	0	0	12.7	0	0	0	0	0	73.8	32.1
413616	Allis Chalmers Corp., City of West Allis	49	77.6	20.4	1.43	0	0	0	0	0	0	0	0	0	0	0	89.8	89.8

*All stations have automatic sampling and continuous flow monitoring instruments.

**Land use categories in 1975 are: 1-industrial, 2-commercial, 3-roads, 4-high density residential, 5-medium density residential, 6-low density residential, 7-land under development, 8-row crops, 9-pasture and small grains (include park, recreational, institutional and unused land), 10-forested land and wood lots, 11-wetlands, 12-feedlots, 13-landfill and dumps, 14-water areas.

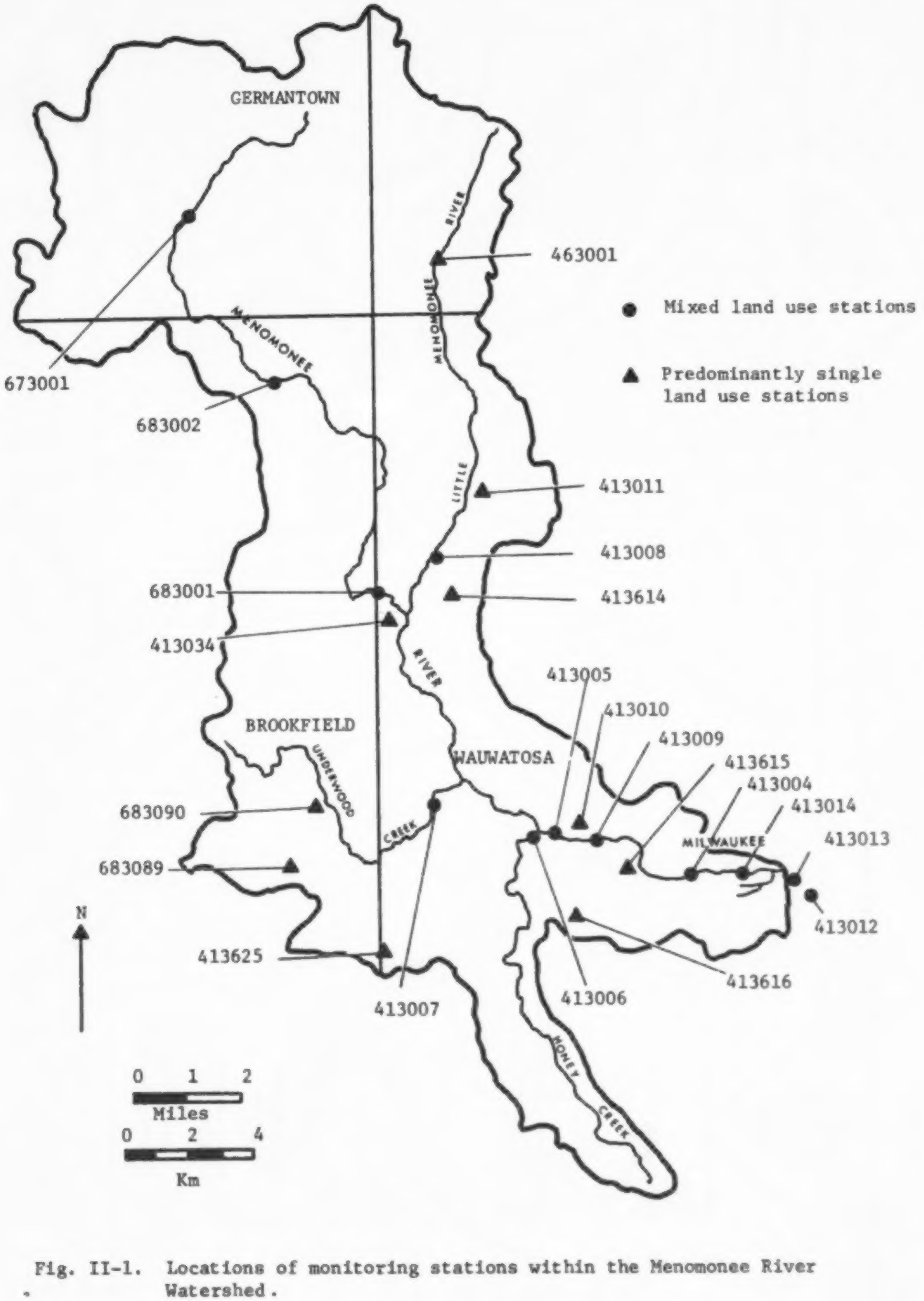
GERMANTOWN
MENOMONEE RIVER
463001
● Mixed land use stations
▲ Predominantly single land use stations
MENOMONEE
673001
683002
LITTLE MENOMONEE RIVER
413011
413008
683001
413614
413034
413005
413010
413009
413615
413004
413014
413013
BROOKFIELD
UNDERWOOD CREEK
WAUWATOSA
683090
MILWAUKEE
683089
413012
N
413625
413616
413007
413006
HONEY CREEK
0 1 2
Miles
0 2 4
Km

Fig. II-1. Locations of monitoring stations within the Menomonee River Watershed.

Table II-2. Flow control structure and sampling equipment* used at the single land use monitoring sites

STORET number	Predominant land use	Drainge system	Control structure	Stage recorder	Sequential water sampler
463001	Agricultural	Natural ditches	**	Bubble gage	USGS PS- 69
413010	Medium density residential	Storm sewered	**	Bubble gage	USGS PS- 69
413011	Medium density residential	Storm sewered	**	Bubble gage	USGS PS- 69
413625	Low density residential	Natural ditches	H-flume	Stevens Type A Model 71	ISCO Model 1680
683090	Low density residential	Natural ditches	H-flume	Stevens Type A Model 71	ISCO Model 1680
413614	Commercial (Airport)	Storm sewered	Palmer Bowlus (P-B) flume	Stevens Type A Model 71	ISCO Model 1680
413615	Freeway	Storm sewered	P-B flume	Stevens Type A Model 71	ISCO Model 1680
683089	Commercial	Storm sewered	P-B flume	Stevens Type A Model 71	ISCO Model 1680
413034	Commercial-light industry	Storm sewered	P-B flume	Stevens Type A Model 71	ISCO Model 1680
413616	Heavy industry	Storm sewered	H-flume	Stevens Type A Model 71	ISCO Model 1680

*Stilling well made of corrugated pipe was needed for the Stevens stage recorder; wooden or brick box houses were used as protective enclosures.
**No flow control structure required.

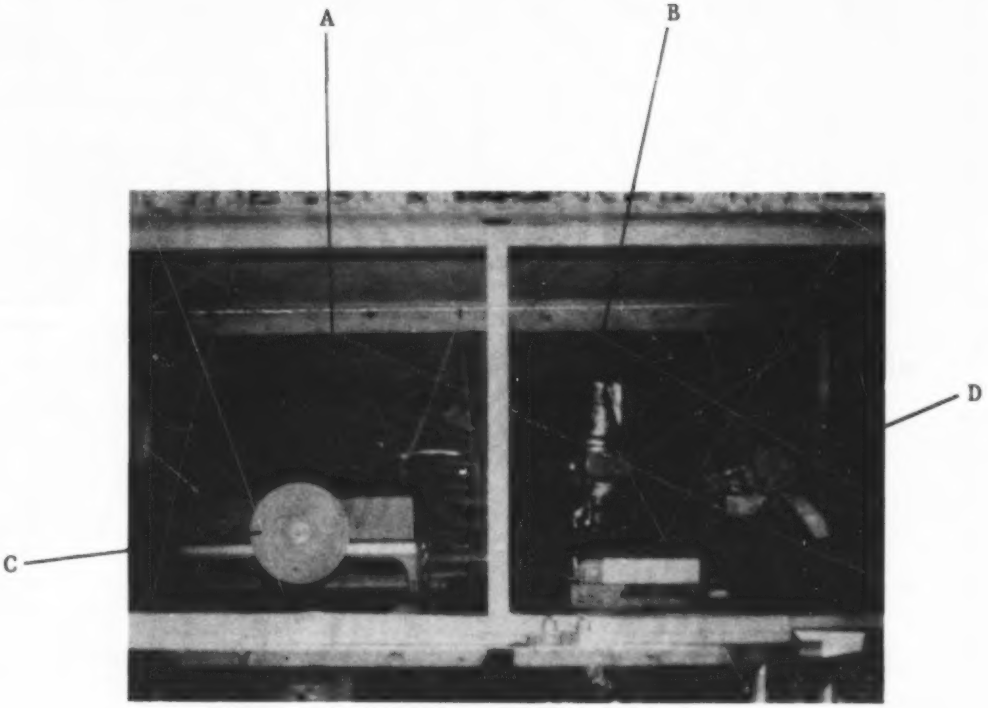

Fig. 2. Typical arrangement of flow recording and water sampling equipment (A - Stevens recorder, B - ISCO sampler, C - stilling well and D - 12-volt battery).

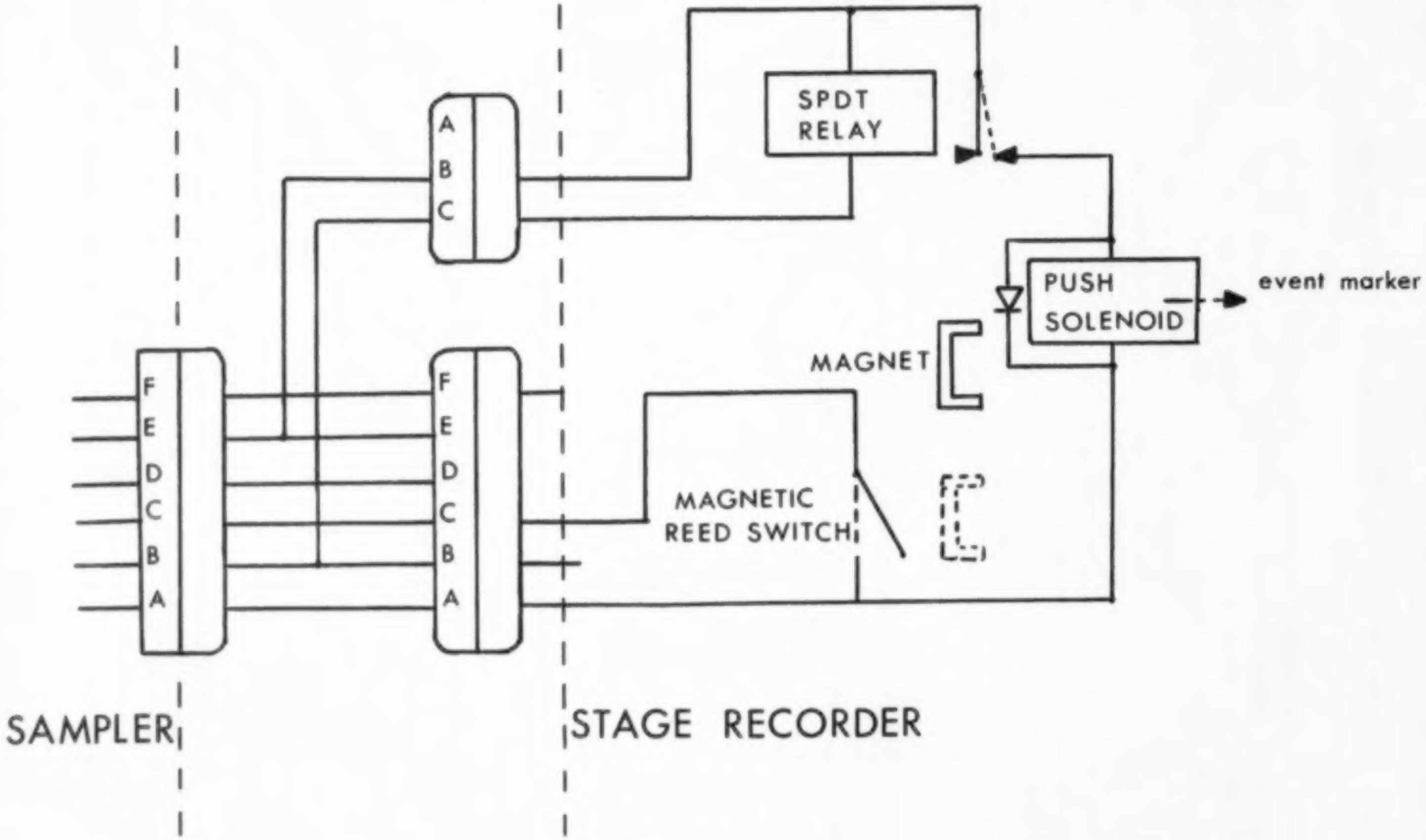
SPDT
RELAY
A
B
C
PUSH
SOLENOID
event marker
MAGNET
F
E
D
C
B
A
F
E
D
C
B
A
MAGNETIC
REED SWITCH
SAMPLER
STAGE RECORDER

Fig. II-3. Schematic of electromechanical system for sampler actuation and event marker.

Sample Collection, Handling and Preservation

During storm events, samples at sites 463001, 413010 and 413011 were collected by PS69 samplers using the "time" mode, i.e. samples were taken at a predetermined time interval (see Part I for description of sampling). Samples from the other stations (413616, 413615, 413010, 413011, 683089, 413034, 463001, 413625 and 683090) were obtained either by "time" or "flow" modes. During spring snowmelt, when the stage increased slowly during the day, the ISCO samplers were actuated in the "time" mode by a microswitch on the moving pen assembly of the water level recorder. During the remainder of the sampling season, the samplers were actuated in the "flow" mode by a reed switch mounted opposite the float wheel of the water level recorder as described earlier. Magnets, mounted near the circumference of the float wheel, closed the switch and actuated the samplers for a predetermined change in water level.

Table II-3 shows the storm events sampled in 1976 and 1977 at the predominantly single land use monitoring sites. Several samples were obtained over the hydrograph during an event. The inclusive dates corresponding to the seasons for the 2-year period were as follows:

Season	1976	1977
Spring	Feb. 10 to May 31	Mar. 3 to May 31
Summer	June 1 to Sept. 30	June 1 to Sept. 30
Fall	Oct. 1 to Dec. 20	Oct. 1 to Dec. 20
Winter	Dec. 21 to Mar. 2	Dec. 21 to Mar. 2

The spring season was reckoned as the first snowmelt that resulted in runoff.

Samples were collected and/or composited at the sites as quickly as possible after an event. Different sample volumes were required for the various parameter groups analyzed (Table II-4). Samples for nutrients and other parameters (1 L), bacteria (250 ml) and metals (250 ml) were contained in plastic bottles while those for organic (2 to 3 L) parameters were stored in glass bottles. Samples were either sent immediately to the State Laboratory of Hygiene at the University of Wisconsin-Madison (a distance of 113 km) or, if not warranted, brought to the Wisconsin Department of Natural Resources (WDNR) Southeastern District Laboratory in Milwaukee, for appropriate storage (Groups A and C samples were frozen; Group D samples were refrigerated). All samples except those for Group D were packed with ice in insulated containers and sent via a special U.S. mail-parcel post to the State Laboratory of Hygiene for analysis. Samples for Group D parameters were picked-up from the DNR Southeastern District Laboratory.

Non-event or baseflow samples were collected by manual activation of the water samplers. Only sites 463001 and 413011 were sampled during baseflow because the other stations either had intermittent or no flow during dry periods. The handling and volumes of samples for the various groups of parameters were the same as those for the event samples.

Table II-3. Storm events sampled* in 1976 and 1977 at the predominantly single land use monitoring sites

STORET number	1976	1977
413010	2/12 2/16† 2/24† 3/4† 4/23† 5/15 6/18† 7/28^{++} 8/28† 9/1† 9/9† 9/19† 10/4† 10/24 10/30	2/11 2/12 3/3 3/27† 4/20 6/8 6/30 7/20 8/3† 8/5 8/8 8/9 8/13 8/28 9/1 9/4 9/12^{++} 9/17
413011	2/12 2/24† 3/4† 3/12† 4/23 5/5 5/15 6/18† 7/28^{++} 8/5† 8/25† 8/28† 9/19† 10/4† 10/24† 10/30†	3/3 3/12† 3/18 3/27 4/1† 4/20† 4/27 5/5† 5/21† 6/5† 6/5 6/8 6/11 6/30 7/6 7/20 8/4 8/9 8/22 8/28 9/1 9/4 9/12^{++} 9/17 9/23
413034**		4/20 5/31 6/8 7/6 8/4^{+} 8/6^{+} 8/9 8/13 8/28 9/1 12/17
413614	5/28 6/13 7/30 8/5 8/25 9/19 10/4	2/11 2/23 3/3 4/4 4/21 6/4 6/5^{+} 6/8 6/17 6/30 7/6 7/17 7/21 7/24 8/3 8/4 9/30^{+}
413615	8/5 10/4	2/10 2/11 2/12 2/23 3/3 3/12 3/28 3/29 4/2 4/2 4/20 4/24 5/4 5/31 6/5^{+} 6/5 6/17 6.28 6/30 7/6 7/17 7/20 7/24^{+} 8/2 8/3^{+} 8/4 8/5 8/13^{+} 8/16 8/21 8/28 9/1 9/4^{+} 9/17 10/7 12/17
413616	6/30 8/25 9/19 10/4	3/3 3/28 4/2 4/4 4/20 6/5^{+} 6/5 6/8 6/17 6/28^{+} 7/17 7/24^{+} 8/3^{+} 8/5 8/8 8/9 8/13 9/12 9/30
413625	9/9	3/12 6/5 6/30^{+} 8/13^{+} 8/28^{+} 9/24^{+} 9/30 10/7
463001	2/12 2/24† 3/4† 3/12† 4/23 5/5† 5/15† 6/14 7/28^{++} 7/30† 10/4† 10/24† 10/30†	3/3† 3/27† 4/1† 6/5 6/5† 6/11† 7/18^{++} 7/20 8/4 8/13 9/23 9/30† 10/7
683089	5/28 6/13 6/18 7/28 9/19	3/28 4/2 4/5 4/20 6/5^{+} 6/17 6/28 6/30 7/6 7/17 7/24 8/2 8/4 8/9 8/13 8/16 8/26 9/1 9/17 9/23 9/30 10/7
683090***		3/28 4/2 7/24^{+} 8/13^{+} 8/28^{+} 9/24^{+} 10/7

*Runoff samples were analyzed for solids, nutrients and metals unless otherwise specified; three or more samples were collected during each event.

**No sampling in 1976.

***No runoff in 1976.

+Runoff samples from these events were also analyzed for pesticides and/or PCBs.

++Runoff samples from these events were also determined for bacteria.

†Runoff samples from these events were not analyzed for metals.

Table II-4. Water quality parameters

Parameter group			
A	B	C	D
Organic N	Total coliform counts	Copper	PCBs
Ammonia-N	Fecal coliform counts	Lead	DDT
Nitrate + nitrite-N	Fecal streptococci counts	Zinc	DDD
Total P		Chromium	DDE
Dissolved reactive P*		Arsenic	Heptachlor
Alkalinity		Selenium	Aldrin
Hardness		Nickel	Lindane
Chloride		Cadmium	Heptachlor epoxide
Total organic C		Iron	Dieldrin
Suspended solids		Manganese	Methoxychlor
Volatile suspended solids		Aluminum	
Total solids		Dissolved reactive silica	

*Also filtered reactive P and is referred to as soluble P in the text or elsewhere.

Nutrient analysis and bacterial counts were performed immediately after receiving the samples in the laboratory. Samples for metal analyses were acidified and refrigerated after removing aliquots for the analysis of dissolved reactive silica. Samples for organics were refrigerated until extraction could be performed.

Laboratory Analysis

Groups A and B parameters

Analysis of parameters under Groups A and B were performed at the State Laboratory of Hygiene. Nutrient forms under Group A parameters were determined following the procedures recommended by the U.S. Environmental Protection Agency (3). Group B and the rest of Group A parameters were determined according to the methods described in (4).

Groups C and D parameters

These parameters were analyzed in the Water Chemistry Laboratory of the University of Wisconsin-Madison.

Samples for metal analysis were acidified in the shipping bottles (3 ml HNO_3/50 ml sample) after aliquots (25 ml) were removed and filtered through 0.4 μm Nucleopore membrane for dissolved reactive silica determination. Acidified samples were digested according to the technique recommended by the U.S. Environmental Protection Agency (3) for total metals in waters. Depending upon the level of metals, concentrations were determined by flame or flameless atomic absorption spectrophotometry (AAS) using a Perking-Elmer Model 603 Atomic Absorption spectrophotometer equipped with an HGA 2100 graphite furnace accessory. Iron, Mn, Zn and Cu were analyzed by flame AAS while Cr, Cd, Ni and Ac--because of their low concentration--were detected by flameless AAS utilizing a deuterium arc background correction. The detection of Pb required an electrodeless discharge source to lessen noise and permit a greater expansion scale. Iron and Al were measured to 100 μg/L; Zn, Cu, Mn and Pb to 10 g/L; and Cr, Cd, Ni and As to 1.0 μg/L. Selenium was not determined regularly because of its extremely low concentrations in runoff water, thus adequate deuterium background correction was not attained.

Dissolved reactive silica was determined by formation of the silicomolybdate complex and spectrophotometric measurement of the absorbance at 810 m (5).

Extraction of organochlorine insecticides and PCBs from runoff samples was accomplished using the U.S. Environmental Protection Agency method (6). Further cleanup of extracts was performed utilizing the alumina column chromatography technique to obtain samples suitable for PCB analysis.

Calculation of Loadings

Water loadings were estimated by integration of flows over the hydrographs of all events recorded. Parameter loadings were calculated using a stratified random sampling statistical model enhanced by a ratio estimator described in (7).

Key Parameters

Two major types of pollution arising from nonpoint sources have been identified in the Great Lakes Basin, namely, nutrients and sediment which accelerate eutrophication of lakes and toxic materials which constitute a public health hazard and a hazard to the biological communities of the lakes. The basic guidelines used in selecting key parameters for these types of pollution are 1. the pollutant must be present in significant amounts in the watershed and 2. it must be amenable to remedial control measures. The key parameters selected include suspended sediment; total phosphorus; toxic metals, primarily Pb, Cd, Cu, and Zn; and toxic organic materials, principally pesticides, PCB, and phenols. The parameters deemed to be of greatest importance in the Menomonee River Watershed are: Suspended sediment, total phosphorus, lead and cadmium. Discussion of results will focus primarily on these parameters.

II-4. RESULTS AND DISCUSSION

Flow and Concentration

Seasonal flow and concentration

Detailed flow and concentration data for storm events measured in 1976 and 1977 as well as concentration data of non-event samples obtained in the same period were placed in STORET. Computer tapes and printouts of the data are available from the Water Resources Center, University of Wisconsin-Madison.

Event seasonal flow and concentrations of 24 parameters in ten predominantly single land use monitoring sites during 1976 and 1977 are presented in Appendix II-A, Tables II-A-1 to II-A-26. These tables contain arithmetic means and ranges of flow and parameter concentrations, standard deviations and number of samples for each station.

Although flow and concentration measurements were made for 1976 and 1977 only the latter data were used for comparison because 1. drought conditions occurred in 1976 and 2. stations were sampled uniformly in 1977. The highest flow of runoff water was observed during summer at most stations and only a slight flow variation occurred between spring and fall. Generally, the highest concentrations of suspended solids, total P, lead and cadmium occurred in spring. It is interesting to note that the stations with the highest concentrations of suspended solids also had the highest concentrations of total P, lead and cadmium. Such high concentrations of suspended solids and associated parameters during spring could be due to low flow and/or to more particulate materials available for transport. However, it appears that more particulate materials are transported in spring as borne out by the considerably lower concentrations of suspended solids and associated parameters in the fall compared with spring despite the similarity of flows during the two seasons. Soluble P (dissolved reactive P) concentrations did not vary between spring and summer. Chloride concentrations in spring were high largely as an aftermath of road salting during previous winter months.

Flow and parameter concentrations differed widely between stations during a season. In general, runoff flows were high for stations that have high connected imperviousness, e.g., stations 413616, 413615 and 413010. Lower flows were observed for stations with low connected imperviousness as shown at sites 683090, 413625 and 413614. High levels of suspended solids and total P were detected at stations 463001, 413615, 413010, 413616, 683089 and 413034. The relatively high concentrations of suspended solids and total P at station 463001 indicate that soil erosion is active and fertilizer being applied in the adjacent agricultural drainage area. High concentrations of lead were found at stations 413615, 413616, 413034, 683089 and 413010. Highest values occurred at sites 413615 and 413616; the drainage areas of both stations are freeway and heavy industrial complex, respetively. Automobile exhaust may contribute largely to the high amounts of lead in heavily traveled areas. Low lead concentrations were shown in areas of lower traffic density as exemplified by site 463001 (largely agricultural land use) and site 683090 (a low density residential area).

Seasonal non-event or baseflow parameter concentrations were determined for two stations--463001 and 413011 (Table II-A-27 and _I-A-28). The other eight stations either had intermittent flow or remained dry during non-event periods. Generally, non-event concentrations of several parameters were lower than event concentrations. This was exemplified by suspended solids, total P and to some degree by soluble P. Lead concentrations tended to be lower during non-events than during events although comparable data were obtained only in the spring of 1976. The higher parameter concentrations observed during events suggest that more materials are being carried by the runoff water although dilution is occurring concomitantly as a result of greater flow.

Bacteriological and organic pollutants

Bacterial counts were determined in non-event and event samples at three stations (Table II-A-29). Although determinations were performed on only a few samples, there was a tendency for coliform and fecal streptococcus counts to be higher during events in the two medium density residential sites (413011 and 413010); this observation was not repeated at the agricultural site (463001).

Organochlorine insecticides and PCBs were scanned for a number of event samples. Levels of organochlorine insecticides were below detection limit. PCBs were detected sporadically during some events, particularly in the heavy industrial (413616) and freeway (413615) sites (Table II-A-30).

Comparison of stormwater runoff quality with water quality criteria

Overall event mean concentrations of selected parameters during 1976 and 1977 at ten predominantly single land use sites were compared with water quality criteria for domestic water supply and aquatic life (Table II-A-31). The water quality values are recommended maximum limits designed to protect the beneficial uses of receiving water with a reasonable degree of safety. If a monitored concentration exceeds the criteria, it does not mean that a problem exists but rather may indicate important sources of pollutants.

The following list summarizes those parameters that exceeded the recommended beneficial use criteria:

Site STORET no.	Domestic water supply	Aquatic life
413616	Pb, Cd, Cr	Suspended solids (SS), Total P, Zn, Cu Cd
413615	Pb, Cl	SS, Total P, Zn, Cu
413034	Pb	SS, Total P, Zn, Cu
413010	Pb, Fecal coliform	SS, Total P, Zn, Cu
413011	Pb	SS, Total P, Zn
683089	Pb	SS, Total P, Zn
413614	Pb	SS, Total P, Zn
413625	Pb	SS, Total P, Zn
463001	Pb	SS, Total P, Zn
683090	Pb	Total P, Zn

Lead appears to be the main contaminant affecting the impairment of domestic water supply. Mean values in all sites exceeded the limit. Except for the agricultural (463001) and low density residential (683090) areas almost all observed concentrations were higher than the recommended limit. Some stations had runoff contaminated with other elements, i.d., cadmium and chromium in the industrial site (413616) and chloride in the freeway area (413615). Since metals were analyzed as total (particulate and soluble), caution should be taken in comparing their concentrations with the criteria.

Bacterial counts in runoff tended to increase during storm events. In three stations (413010, 413011 and 463001) where bacterial analysis was performed, the swimming water criterion for fecal coliform was exceeded only at site 413010, an established medium density residential area.

Stormwater runoff contains several contaminants that may affect its beneficial use for aquatic life. Among the contaminants are suspended solids, total P and such metals as zinc, copper and cadmium. Runoff mean concentrations of total P and zinc at all stations exceeded the criteria. The limit for suspended solids was exceeded at all sites except the low density residential area (683090); copper at the established medium density residential site (413010), the light industry site (413034), the freeway (413615) and the heavy industrial site (413616); cadmium criteria were exceeded only at the heavy industrial site.

The runoff contaminants arising from various land uses that are most likely responsible for water quality impairment are lead for domestic water supply; suspended solids and zinc for aquatic life; total P for eutrophication; and fecal coliform for swimming.

Parameter concentration relationships

Correlation analyses between parameter concentrations were performed for all data in 1976 and 1977 and by season at eight stations; correlation matrices are presented in Tables II-A-32 and II-A-33.

Multicolinearity did exist among many of the water quality parameters (Table II-A-32). For example, high simple correlation coefficient values ($\leq$ 0.50) were demonstrated for 1. suspended solids with volatile suspended solids, total P, total organic N, total organic C, copper, lead, zinc, arsenic, nickel, iron, aluminum and manganese; 2. total P with the parameters listed above and 3. among metals with the exceptions of cadmium and chromium and occasionally with selenium. These relationships indicate the close association of several of the paremters, particularly nutrients (except soluble species) and metals, with suspended solids and the strong interrelationships among lead, copper, zinc, arsenic, nickel, iron and manganese. Apparently, the lower correlation observed for chromium and cadmium with suspended solids is due to their weaker binding by solids as compared to the other metals.

A significant correlation between suspended solids and total P was observed almost consistently for each season at all stations (Table II-A-33). This trend was also found between suspended solids and lead and between total P and lead except at sites 463001 and 683090. The breakdown in the colinearity among these parameters in the two sites could be explained largely by the low amounts of lead arising from the agricultural (463001) and low density residential (683090) drainage areas. Soluble P tended to have a low or inverse relationship with suspended solids. It is likely that either the concentration of soluble P does not change or it decreases with the increase in suspended particles in the runoff water.

The strong positive correlations of suspended solids with total P and several of the metals particularly lead suggest that a management scheme which includes removal of suspended solids from stormwater runoff also reduces associated pollutants.

Relationships among flow, concentrations and loading rates during events

Well-sampled events were selected from five stations--413615, 413011, 683090, 413625 and 463001--to illustrate typical variations of concentrations and loading rates (instantaneous load) of suspended solids, total P, lead and soluble P during an event (Figs. II-A-1 to II-A-7). The loading rate was calculated by multiplying flow with the concentration at the time a sample was collected. The percent load represents cumulative load; the number on the last point being the total load at the end of sampling. In order to gain further insight into the relationship of flow, concentrations and input rates, regression and correlation analyses were performed and examples of plots are shown in Figs. II-A-8 to II-A-13.

The data reveal that:

1. In general, the concentrations of suspended solids, total P and lead increased during the rising stage of the hydrograph (Figs. II-A-1 to

II-A-7). Highest concentrations occurred early in the storm usually near the vicinity of peak flows. The relationship between the concentration of soluble P and flow was not as distinct as the above parameters. Highest concentrations of this soluble component were attained either early in the storm or lagged after peak flows.

Although increased flow promotes dilution, it produces simultaneous scouring of soil particles or particulate matter initially present on the land surface, hence the increasing concentrations of suspended sediments and associated pollutants during the rising stage of the hydrograph. The decrease of concentrations during the falling stage indicates the exhaustion of source materials.

Concentrations of parameters were found to be ocassionally correlated with flow during events. These kinds of relationships are depicted in Figs. II-A-8 and II-A-9.

2. Loading rates of suspended solids, total P, lead and soluble P were associated closely with flow and concentration (Figs. II-A-1 to II-A-7). High correlations existed between loading rate and flow but not consistently between loading rate and concentration (Figs. II-A-10 to II-A-13).

It is noted that for several events examined loading rates tend to have a consistently stronger correlation with flow than with concentration. This implies that flow exerts greater influence on loading than concentration.

3. A wide variation in concentrations occurred over the hydrograph. This emphasizes the importance of obtaining several samples during runoff to obtain a better representation of the event.

4. Generally, more than half of the total load of the parameters selected was transported immediately following major flows during events (Figs. II-A-1 to II-A-7).

Event concentrations and loading rates of parameters other than those mentioned above are presented in Tables II-A-34 to II-A-41 for selected stations.

Monitored Loading Data

Seasonal loadings

Pollutant loadings were calculated using a stratified random sampling statistical model enhanced by a ratio estimator while water loadings were obtained by integration of flow for all events. Seasonal event unit loadings of water and 21 pollutants deteremined at the ten predominantly single land use sites are presented in Tables II-A-42 to II-A-63. Included in the tables are 95% confidence interval values estimated for the loads and flow-weighted concentrations of pollutants. A pollutant load divided by the corresponding water load gives the flow weighted concentration for that pollutant.

Water and pollutant loadings varied considerably from season to season at each station and from station to station for each season. During 1976 and 1977 highest loads occurred in different seasons. In 1976, the highest pollutant loadings (suspended solids, total P and soluble P) was observed in spring as exemplified by station 413010, 413011 and 463001--the only stations sampled completely during the year. Conversely, in 1977, major portions of the loads of suspended solids, nutrients and several of the metals for most of the stations were generated in summer. It is evident that the seasonal variation of pollutant loadings is influenced largely by differences in the amounts of runoff. Most of the annual runoff (> 50%) occurred during spring and summer in 1976 and 1977, respectively. Concomittantly, the main bulk of the annual loads were attained during these seasons.

Examination of pollutant loadings reveal that differences between station within a season are due to the variation in the amount of runoff and/or pollutant concentration. High pollutant loadings observed at stations 413616, 413615, 683089, 413011 and 413010 were related to high water loads and usually to high pollutant concentrations. For example, this effect was exhibited for suspended solids and associated pollutants such as total P and lead. Stations with low pollutant loads (413625 and 683090) had also low water loads and generally low pollutant concentrations. The two components may exert varying degrees of influence but the data indicate that the runoff yield has a greater effect on the magnitude of pollutant loads from station to station.

Factors affecting loadings

In the analysis of pollutant loadings from predominantly homogeneous areas, consideration must be given to their respective components. To the degree that concentrations are similar, variations in pollutant loadings are attributable to differences in the amounts of water load or runoff. Likewise, to the degree that the amounts of runoff are similar, variations in pollutant loadings are due to differences in concentration. Elaboration of the factors affecting these components, hence pollutant loadings, is extremely important so that those feasible to control through management practices can be identified.

This dualistic analysis of stormwater pollution yields a two-sided relative hazard-ranking systems. One aspect involves the hydraulic factors which determine the relative amounts of runoff. In urban areas, these primarily involve the nature of the drainage system and the degree of imperviousness. The connectedness of impervious surfaces to drainage systems determines the rapidity by which water is transported from the drainage areas to receiving streams. Of lesser importance in determining runoff in urban as compared to rural watersheds are soil permeability, slope, ground cover, depression storage, etc. Storm-sewered areas with relatively high connected imperviousness (413616, 413615 and 683089) do not only generate high amounts of runoff but also typically export high pollutant loads. Additionally, there is not a strong dilutional effect caused by the larger amounts of water. Rather, those stations with high unit amounts of runoff often have high concentrations of pollutants. This is likely caused by the easy washoff and efficient transport of pollutants in curb and gutter storm sewer systems from impervious surfaces, and the more intensive scour and transport capacities of larger volumes of water. Stations with natural drainage systems and low connected imperviousness (413625 and 683090) have relatively lower runoff and typically generate much lower pollutant loads.

The other aspect of the relative hazard-ranking system pertains to those land activities, land uses and land covers that affect the concentrations of pollutants. Some of these are long term factors which result in persistently high concentrations, such as lead values from heavy traffic or heavy industry at stations 413615 and 413616, respectively. Inversely, some factors cause persistently low concentrations such as the apparent increased trapping efficiency for suspended solids and associated pollutants at stations 413625 and 683090 (statistical analysis shown earlier revealed a significant correlation of suspended solids with total P, lead and concentrations of other metals indicating that the latter pollutants are strongly correlated with the solids fractions). Other factors affecting pollutant concentration are of short term duration, i.e., either temporary or seasonal activities. Most visibly are the effects of winter salting activities or chloride values at station 413615 during spring and on suspended solids concentrations at station 683089 in the spring of 1977. Some of the short term activities may mask longer term differences, as at station 413011 where the impacts of ongoing construction throughout the study period are impossible to separate from non-construction related loads.

Water is the prime mover of pollutants and the more runoff generated over the land surface the greater the pollutant loads. This relationship is clearly demonstrated in Figs. II-A-14 to II-A-17). Loads of pollutants such as suspended solids, total P, lead and soluble P increased significantly with increased amounts of runoff regardless of the type of land use monitored. The single most important hydraulic factor affecting the generation of runoff, and correspondingly pollutant loads, during storm events is the connectedness of impervious areas to the drainage systems or receiving waters. As shown for the 1977 data (Figs. II-A-18 to II-A-22), water and pollutant loadings were related to the connected imperviousness; significant correlation being observed more consistently for the summer and annual loads.

It is apparent that no blanket remedial policy based solely on type of land use is advisable. Rather, remedial measures should be oriented towards curtailing those short term activities or phenomena which result in high pollutant concentrations, and towards those areas, which because of their hydraulic and/or other indigenous characteristics, generate long term heavy pollutant loads. Undoubtedly, minimization of connected imperviousness in any future development or urbanization schemes could effectively and inexpensively prevent high pollutant loads.

Rainfall-Runoff Relationships

The amount, frequency and intensity of rainfall affects the amount of runoff and resultant pollutant loads. These factors exert varying degrees of influence and they may either enhance or depress runoff. Only the effects of rainfall size and frequency are discussed. On-site rainfall and corresponding runoff data obtained mostly in the summer of 1977 are shown in Table II-A-64. Local variation in rainfall distribution was observed at the sampling sites. For the same event, larger runoff usually occurred in the relatively impervious areas (413615, 683089, 413011 and 413010) than in the pervious areas (413625, 683090 and 463001). Correlation analysis of the data demonstrated clearly that a significant direct relationship existed between the amount of runoff and rainfall for the relatively impervious watersheds (Fig. II-A-23). This relationship was not substantiated in more pervious watersheds, probably because larger rainfalls are needed to exceed the saturation/infiltration capacity of the soil before runoff occurs. Further analysis of the data showed the absence of significant correlation between percent runoff and rainfall at any of the sites (Fig. II-A-24). This suggests that the percentage of runoff frequently does not increase with the size of an event.

Seasonal rainfall distribution at the various monitoring stations was obtained by averaging information from all USGS rain gauges closest to the sites (Table II-A-65). Most of the rainfall (> 60%) occurred during spring in 1976 and during summer in 1977. A major portion of the annual runoff was also generated during these seasons. It is interesting to note that as shown earlier for individual events 1. the lowest seasonal runoff generally occurred at the relatively pervious watersheds and 2. the amount of runoff did not increase correspondingly with higher seasonal rainfall in such areas.

The rainfall frequency or time elapsed since the last rainfall affects the amount of runoff and accompanying pollution in two ways. In rural or relatively pervious areas the amount of runoff should depend to a certain extent upon the antecedent soil moisture conditions prior to an event. When soil moisture content is high--which may occur when the intervals between events is small--the infiltration capacity is exceeded rapidly resulting in greater runoff and pollutant loads. Pollutant loadings in relatively impervious areas may increase with prolonged intervals between events due to accumulation of dust and dirt. Analysis of integrated water and parameter loading data for well-sampled storm events (Table II-A-66), however, showed no significant correlation existed between loadings and days elapsed since the last rainfall at any of the monitoring sites (Table II-A-67). Such low correlations ($r = -0.422$ to 0.464) indicate the futility of predicting loadings based upon rainfall frequency because different storm events vary in size and intensity. Furthermore, data from this study cast serious doubt upon the validity of the assumption that pollution from urban runoff increases with time elapsed since the previous rainfall (10).

First Flush Analysis

A frequently noted observation cited in the literature is the first flush phenomenon, or the occurrence of highly concentrated pollutants in the early stages of runoff. It has been commonly noted for areas of combined sewers that the first overflows carry with them high concentrations of scoured or flushed deposits. As defined in this study, first flush occurs when the percent of the total parameter loads discharged at any point in an event exceeds significantly the corresponding percent of total water loads discharged. First flush is expected to be more prevalent during larger storm events.

Cumulative water and parameter loads obtained by integration, for closely monitored events are given in Table II-A-68 in urban areas with high (683089), low (413614) and extremely low or negligible (413625 and 683090) connected imperviousness. The amounts of rainfall during the events were considered moderate to high (1.0 to 4.0 cm). Analysis of data indicates that first flush occurred at all sites, particularly for suspended solids and associated parameters such as total P and lead. Only occasional first flush was observed for the dissolved species exemplified by soluble P. The occurrence of first flush was more frequent at site 683089 which may be explained largely by the higher connected imperviousness of its drainage area which allowed easier transport of materials to the storm sewer system. The concentration surge during the early stages of some events, as discussed previously, is dependent on the amount of materials available for transport. Usually more materials are available for transport during the initial stages of an event. However, trapping of materials during the course of transport such as along natural drainage systems of pervious areas tend to minimize first flush.

The implications of these findings are twofold, and are applicable to areas with separate storm sewers or natural drainage ways. First, storage and treatment of the initial portions of runoff may remove significant amounts of pollutants depending upon the drainage areas under consideration. Second, as the amount of pollutants are closely associated with the amount of runoff, efforts to reduce the latter will result in reduction of pollutant loadings.

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APPENDIX A. MONITORING DATA AT THE PREDOMINANTLY SINGLE LAND USE SITES

Appendix II-A contains tabular and pictorial materials which are grouped in the following manner to correspond to the order shown in the main text.

Table or Figure Nos.	Description
Tables II-A-1 to II-A-26	Flow of water (in cms), concentration of parameters (mg/L) and pH at the predominantly single land use monitoring sites during events.
Tables II-A-27 and II-A-28	Concentrations of parameters (mg/L) at the predominantly single land use monitoring sites during baseflow.
Table II-A-29	Bacterial counts in non-event and event samples collected at three predominantly single land use monitoring sites.
Table II-A-30	Concentrations of PCBs during events at the predominantly single land use monitoring sites.
Table II-A-31	Comparison of mean concentration of selected parameters during events in 1976 and 1977 with water quality criteria at the predominantly single land use monitoring sites.
Tables II-A-32 and II-A-33	Correlation coefficients (r) for water quality parameter concentrations.
Figs. II-A-1 to II-A-7	Flow and parameter concentrations and loadings for different events at various monitoring sites.
Figs. II-A-8 to II-A-13	Relationships of parameter concentrations and flow for different events at various monitoring sites.
Tables II-A-34 to II-A-37	Flow and parameter concentrations for selected events at various monitoring sites.

Table or Figure Nos.	Description
Tables II-A-38 to II-A-41	Flow and parameter input rates (instantaneous load) for selected events at various monitoring sites.
Tables II-A-42 to II-A-63	Seasonal loadings of various parameters at the predominantly single land use monitoring sites.
Figs. II-A-14 to II-A-17	Relationships of parameter loadings and runoff at various monitoring sites.
Figs. II-A-18 to II-A-22	Relationships of parameter loadings and degree of connected imperviousness.
Table II-A-64	Observed rainfall and runoff at the predominantly single land use monitoring sites.
Figs. II-A-23 and II-A-24	Relationships of amount of runoff and rainfall at selected sites.
Table II-A-65	Seasonal and annual rainfall and runoff at the predominantly single land use monitoring sites.
Table II-A-66	Effect of frequency of rainfall on event loads at the predominantly single land use monitoring sites.
Table II-A-67	Regression equation and correlation coefficients (r) of rainfall frequency with runoff and load of selected parameters at the predominantly single land use monitoring sites.
Table II-A-68	Relationships of water and parameter load during events at selected dates and stations.

For Tables II-A-1 to II-A-28, water flow is given in cms and all other parameters except pH are in mg/L

Table II-A-1. Seasonal averages and ranges of flow of water at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	51	33	11	0	95	12	66	2	80	175	COUNT, FLOW
	.207	.406	.218	-	.278	.216	.687	.210	.571	.412	MEAN, FLOW
	.000	.116	.122	-	.000	.025	.119	.193	.025	.000	MIN, FLOW
	1.379	2.605	.481	-	2.605	.821	7.617	.226	7.617	7.617	MAX, FLOW
	.248	.409	.108	-	.357	.309	1.047	.024	.971	.720	SDV, FLOW
413011	57	33	14	0	104	95	119	0	214	318	COUNT, FLOW
	1.083	.158	.136	-	.662	.202	.550	-	.305	.483	MEAN, FLOW
	.025	.000	.011	-	.000	.006	.006	-	.006	.000	MIN, FLOW
	6.088	.849	.708	-	6.088	.934	7.646	-	7.646	7.646	MAX, FLOW
	1.194	.176	.241	-	1.005	.197	1.127	-	.860	.921	SDV, FLOW
413030	0	0	0	0	0	10	52	7	69	69	COUNT, FLOW
	-	-	-	-	-	.069	.327	.113	.268	.268	MEAN, FLOW
	-	-	-	-	-	.003	.003	.086	.003	.003	MIN, FLOW
	-	-	-	-	-	.106	2.312	.167	2.312	2.312	MAX, FLOW
	-	-	-	-	-	.031	.571	.037	.506	.506	SDV, FLOW
413614	9	33	9	27	78	22	56	3	81	159	COUNT, FLOW
	.044	.180	.064	.033	.100	.055	.104	.032	.088	.094	MEAN, FLOW
	.023	.004	.016	.003	.003	.023	.004	.022	.004	.003	MIN, FLOW
	.079	.683	.120	.077	.683	.156	.623	.044	.623	.683	MAX, FLOW
	.017	.221	.031	.024	.159	.037	.141	.011	.121	.141	SDV, FLOW
413615	0	6	7	31	44	62	118	11	191	235	COUNT, FLOW
	-	.149	.198	.052	.089	.111	.665	.098	.453	.384	MEAN, FLOW
	-	.102	.029	.014	.014	.020	.015	.063	.015	.014	MIN, FLOW
	-	.178	.296	.201	.296	.381	4.245	.158	4.245	4.245	MAX, FLOW
	-	.034	.107	.057	.086	.091	.964	.032	.820	.753	SDV, FLOW
413616	0	25	7	0	32	40	90	0	130	162	COUNT, FLOW
	-	1.152	.625	-	1.037	.297	.893	-	.710	.775	MEAN, FLOW
	-	.019	.227	-	.019	.008	.011	-	.008	.008	MIN, FLOW
	-	2.264	.829	-	2.264	.789	2.264	-	2.264	2.264	MAX, FLOW
	-	.861	.233	-	.796	.203	.909	-	.811	.817	SDV, FLOW
413625	0	3	2	2	7	7	30	7	44	51	COUNT, FLOW
	-	.021	.023	.011	.019	.065	.045	.033	.047	.043	MEAN, FLOW
	-	.016	.023	.003	.003	.018	.008	.010	.008	.003	MIN, FLOW
	-	.025	.023	.019	.025	.215	.188	.060	.215	.215	MAX, FLOW
	-	.005	.000	.012	.008	.069	.043	.017	.045	.043	SDV, FLOW
463001	67	18	0	0	85	0	58	9	67	152	COUNT, FLOW
	1.008	.095	-	-	.815	-	.374	.556	.398	.631	MEAN, FLOW
	.156	.006	-	-	.006	-	.011	.079	.011	.006	MIN, FLOW
	4.440	.595	-	-	4.440	-	2.180	1.161	2.180	4.440	MAX, FLOW
	1.084	.139	-	-	1.033	-	.571	.432	.555	.878	SDV, FLOW
683089	9	31	0	0	40	24	84	5	113	153	COUNT, FLOW
	.068	.373	-	-	.304	.089	.406	.103	.325	.319	MEAN, FLOW
	.019	.014	-	-	.014	.005	.003	.038	.003	.003	MIN, FLOW
	.183	1.686	-	-	1.686	.658	2.402	.158	2.402	2.402	MAX, FLOW
	.050	.439	-	-	.407	.145	.563	.050	.508	.483	SDV, FLOW
683090	0	0	0	0	0	15	22	6	43	43	COUNT, FLOW
	-	-	-	-	-	.038	.060	.073	.054	.054	MEAN, FLOW
	-	-	-	-	-	.008	.000	.013	.000	.000	MIN, FLOW
	-	-	-	-	-	.067	.260	.115	.260	.260	MAX, FLOW
	-	-	-	-	-	.022	.073	.041	.057	.057	SDV, FLOW
TOTAL	193	182	50	60	485	287	695	50	1032	1517	COUNT, FLOW
	.730	.371	.214	.042	.457	.159	.501	.172	.390	.411	MEAN, FLOW
	.000	.000	.011	.003	.000	.003	.000	.010	.000	.000	MIN, FLOW
	6.088	2.605	.829	.201	6.088	.934	7.646	1.161	7.646	7.646	MAX, FLOW
	1.007	.549	.240	.045	.762	.179	.859	.257	.731	.742	SDV, FLOW

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Table II-A-2. Seasonal averages and ranges of concentrations of total solids at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	46	31	9	0	86	7	30	37	123	COUNT, T SLD
	897,98	677,68	158,89	-	741,22	1012,86	679,00	742,16	741,50	MEAN, T SLD
	140,00	90,00	60,00	-	60,00	235,00	110,00	110,00	60,00	MIN, T SLD
	2706,00	5260,00	330,00	-	5260,00	2150,00	3485,00	3485,00	5260,00	MAX, T SLD
	695,72	997,74	107,09	-	812,00	687,35	690,57	693,16	775,35	SDV, T SLD
413011	51	33	14	0	98	48	54	102	200	COUNT, T SLD
	943,43	435,67	272,86	-	676,65	799,27	512,69	647,55	661,81	MEAN, T SLD
	4,00	185,00	185,00	-	4,00	355,00	180,00	180,00	4,00	MIN, T SLD
	2958,00	735,00	400,00	-	2958,00	1440,00	3580,00	3580,00	3580,00	MAX, T SLD
	548,28	148,84	63,99	-	493,48	257,13	510,85	434,02	463,16	SDV, T SLD
413034	0	0	0	0	0	10	27	37	37	COUNT, T SLD
	-	-	-	-	-	1337,00	330,56	602,57	602,57	MEAN, T SLD
	-	-	-	-	-	375,00	80,00	80,00	80,00	MIN, T SLD
	-	-	-	-	-	2685,00	985,00	2685,00	2685,00	MAX, T SLD
	-	-	-	-	-	684,16	194,88	591,42	591,42	SDV, T SLD
413614	9	33	9	27	78	13	52	65	143	COUNT, T SLD
	422,89	734,73	320,56	865,37	696,18	503,08	400,00	420,62	570,92	MEAN, T SLD
	175,00	210,00	170,00	445,00	170,00	210,00	165,00	165,00	165,00	MIN, T SLD
	880,00	2320,00	480,00	1760,00	2320,00	1120,00	2195,00	2195,00	2320,00	MAX, T SLD
	240,81	590,05	109,59	280,70	463,10	361,65	313,72	323,54	427,12	SDV, T SLD
413615	0	6	6	17	29	62	89	151	180	COUNT, T SLD
	-	442,50	479,17	2609,41	1720,34	1368,16	608,54	920,44	1049,31	MEAN, T SLD
	-	250,00	200,00	775,00	200,00	275,00	125,00	125,00	125,00	MIN, T SLD
	-	910,00	925,00	5905,00	5905,00	12045,00	2625,00	12045,00	12045,00	MAX, T SLD
	-	245,86	276,29	1135,10	1385,86	1569,70	475,85	1129,34	1206,72	SDV, T SLD
413616	0	25	7	0	32	40	70	110	142	COUNT, T SLD
	-	839,44	692,86	-	807,37	617,37	1014,86	870,32	856,13	MEAN, T SLD
	-	565,00	620,00	-	565,00	300,00	310,00	300,00	300,00	MIN, T SLD
	-	1260,00	860,00	-	1260,00	1490,00	4640,00	4640,00	4640,00	MAX, T SLD
	-	189,30	88,31	-	181,77	281,59	709,30	619,47	551,92	SDV, T SLD
413625	0	3	2	0	5	7	15	22	27	COUNT, T SLD
	-	343,33	82,50	-	239,00	623,57	599,33	607,05	538,89	MEAN, T SLD
	-	260,00	80,00	-	80,00	315,00	230,00	230,00	80,00	MIN, T SLD
	-	415,00	85,00	-	415,00	730,00	2175,00	2175,00	2175,00	MAX, T SLD
	-	78,16	3,54	-	153,19	145,34	492,51	409,73	400,54	SDV, T SLD
463001	60	9	0	0	69	0	30	30	99	COUNT, T SLD
	620,43	652,67	-	-	624,64	-	1098,33	1098,33	768,18	MEAN, T SLD
	318,00	485,00	-	-	318,00	-	485,00	485,00	318,00	MIN, T SLD
	1080,00	1140,00	-	-	1140,00	-	6640,00	6640,00	6640,00	MAX, T SLD
	110,81	201,34	-	-	124,67	-	1242,16	1242,16	717,81	SDV, T SLD
683089	9	30	0	0	39	23	50	73	112	COUNT, T SLD
	501,33	399,70	-	-	423,15	930,87	375,94	550,78	506,34	MEAN, T SLD
	124,00	50,00	-	-	50,00	170,00	75,00	75,00	50,00	MIN, T SLD
	1700,00	1250,00	-	-	1700,00	3135,00	2430,00	3135,00	3135,00	MAX, T SLD
	647,05	353,37	-	-	430,49	781,62	437,45	619,91	562,53	SDV, T SLD
683090	0	0	0	0	0	15	11	26	26	COUNT, T SLD
	-	-	-	-	-	379,00	213,18	308,85	308,85	MEAN, T SLD
	-	-	-	-	-	305,00	175,00	175,00	175,00	MIN, T SLD
	-	-	-	-	-	575,00	320,00	575,00	575,00	MAX, T SLD
	-	-	-	-	-	75,46	52,55	106,17	106,17	SDV, T SLD
TOTAL	175	170	47	44	436	225	428	653	1089	COUNT, T SLD
	771,23	600,98	340,96	1539,20	735,97	917,09	621,64	723,44	728,46	MEAN, T SLD
	4,00	50,00	60,00	445,00	4,00	170,00	75,00	75,00	4,00	MIN, T SLD
	2958,00	5260,00	925,00	5905,00	5905,00	12045,00	6640,00	12045,00	12045,00	MAX, T SLD
	518,13	552,13	216,27	1124,71	667,50	955,82	638,27	774,86	733,47	SDV, T SLD

Table II-A-3. Seasonal averages and ranges of concentrations of suspended solids at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	46 131.76 .01 780.00 172.67	31 489.55 24.00 4390.00 830.61	10 88.20 19.00 240.00 77.20	0	87 254.24 .01 4390.00 536.73	7 489.14 66.00 1624.00 574.85	65 227.62 18.00 1304.00 277.88	2 158.00 92.00 224.00 93.34	74 209.39 18.00 1624.00 337.29	161 261.21 .01 4390.00 454.76	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413011	51 259.00 10.00 2440.00 392.86	33 106.45 5.00 602.00 121.32	14 30.36 12.00 64.00 13.66	0	98 174.97 5.00 2440.00 304.58	49 84.31 8.00 620.00 114.66	105 163.90 1.00 2976.00 351.10	0	154 139.84 1.00 2976.00 298.61	252 153.50 1.00 2976.00 300.83	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413034	0	0	0	0	0	10 880.20 218.00 1772.00 512.68	49 137.51 7.00 888.00 170.72	7 330.43 214.00 592.00 158.16	66 271.45 7.00 1772.00 302.30	66 271.45 7.00 1772.00 302.30	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413614	9 61.33 27.00 145.00 40.54	33 370.09 3.00 1856.00 581.98	9 61.11 4.00 99.00 37.69	27 81.44 7.00 240.00 94.25	78 202.71 3.00 1856.00 408.95	13 173.08 18.00 824.00 242.33	56 116.84 2.00 1808.00 243.99	3 25.67 8.00 43.00 17.50	72 123.84 2.00 1808.00 238.62	150 166.67 2.00 1856.00 339.35	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413615	0	6 76.83 37.00 109.00 27.59	6 215.00 82.00 374.00 119.91	17 422.41 14.00 1244.00 539.17	29 308.41 14.00 1244.00 435.76	62 455.19 12.00 2220.00 495.66	110 295.23 19.00 1548.00 281.61	11 240.45 72.00 494.00 244.30	183 346.49 12.00 2220.00 373.29	212 341.28 12.00 2220.00 381.52	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413616	0	25 280.72 36.00 932.00 226.69	7 171.14 90.00 344.00 91.02	0	32 256.75 36.00 932.00 208.58	40 162.95 10.00 1000.00 201.15	88 364.59 1.00 3588.00 585.71	0	128 301.58 1.00 3588.00 511.53	160 292.61 1.00 3588.00 466.78	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
413625	0	3 238.67 195.00 308.00 60.72	2 16.00 15.00 17.00 1.41	0	5 109.60 15.00 308.00 129.30	7 48.29 30.00 76.00 17.38	30 310.00 12.00 1782.00 413.56	7 108.71 56.00 179.00 40.43	44 236.34 12.00 1782.00 357.41	49 227.49 12.00 1782.00 341.44	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
463001	60 103.42 6.00 706.00 101.32	9 150.56 7.00 460.00 199.36	0	0	69 109.57 6.00 706.00 149.19	0	51 467.92 32.00 6536.00 1046.06	9 186.33 106.00 262.00 47.37	60 425.68 32.00 6536.00 968.66	129 256.60 6.00 6536.00 684.98	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
463089	9 51.33 20.00 87.00 20.40	30 178.67 6.00 716.00 194.20	0	0	39 149.13 6.00 716.00 178.37	23 453.74 21.00 1930.00 642.79	80 171.15 1.00 1442.00 245.38	5 37.20 28.00 51.00 9.12	108 229.13 1.00 1930.00 380.14	147 204.97 1.00 1930.00 339.56	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
463090	0	0	0	0	0	15 27.93 12.00 103.00 22.04	22 24.41 1.00 64.00 20.54	6 35.50 32.00 39.00 2.35	43 27.05 1.00 103.00 19.91	43 27.05 1.00 103.00 19.91	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD
TOTAL	175 151.37 .01 2440.00 253.29	170 271.26 3.00 4390.00 474.42	48 91.19 4.00 374.00 91.93	44 213.18 7.00 1244.00 376.49	437 197.62 .01 4390.00 363.29	226 292.61 8.00 2220.00 438.19	656 239.67 1.00 6536.00 451.03	50 106.34 8.00 494.00 105.20	932 248.90 1.00 6536.00 438.01	1369 232.31 .01 6536.00 416.17	COUNT, S SLD MEAN, S SLD MIN, S SLD MAX, S SLD SDV, S SLD

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Table II-A-4. Seasonal averages and ranges of concentrations of volatile suspended solids at the predominantly single land use monitoring sites.

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	46	31	10	0	87	7	34	41	128	COUNT, VS SLD
	40.09	75.81	32.20	.	51.91	188.29	54.79	77.59	60.11	MEAN, VS SLD
	.01	5.00	6.00	.	.01	19.00	8.00	8.00	.01	MIN, VS SLD
	248.00	296.00	90.00	.	296.00	324.00	160.00	324.00	324.00	MAX, VS SLD
	52.30	80.77	27.57	.	64.13	132.17	42.83	81.97	71.03	SDV, VS SLD
413011	51	33	14	0	98	49	62	111	209	COUNT, VS SLD
	26.57	16.03	10.50	.	20.72	13.10	20.82	17.41	18.97	MEAN, VS SLD
	4.00	3.00	6.00	.	3.00	2.00	1.00	1.00	1.00	MIN, VS SLD
	170.00	48.00	17.00	.	170.00	60.00	144.00	144.00	170.00	MAX, VS SLD
	29.73	10.56	3.28	.	23.12	13.22	25.70	21.39	22.22	SDV, VS SLD
413034	0	0	0	0	0	10	28	38	38	COUNT, VS SLD
	.	.	.	.	.	153.50	25.82	59.42	59.42	MEAN, VS SLD
	.	.	.	.	.	41.00	4.00	4.00	4.00	MIN, VS SLD
	.	.	.	.	.	236.00	98.00	236.00	236.00	MAX, VS SLD
	.	.	.	.	.	63.84	20.65	67.45	67.45	SDV, VS SLD
413614	9	33	9	27	78	13	54	67	145	COUNT, VS SLD
	12.22	55.91	20.00	17.07	33.28	38.23	21.00	24.34	29.15	MEAN, VS SLD
	6.00	2.00	3.00	2.00	2.00	5.00	1.00	1.00	1.00	MIN, VS SLD
	28.00	230.00	31.00	52.00	230.00	160.00	288.00	288.00	288.00	MAX, VS SLD
	6.63	65.40	11.45	17.64	47.80	45.59	40.85	42.01	45.20	SDV, VS SLD
413615	0	6	6	17	29	62	94	156	185	COUNT, VS SLD
	.	30.50	68.17	107.00	83.14	97.29	59.50	74.52	75.87	MEAN, VS SLD
	.	15.00	35.00	4.00	4.00	5.00	6.00	5.00	4.00	MIN, VS SLD
	.	45.00	104.00	316.00	316.00	325.00	270.00	325.00	325.00	MAX, VS SLD
	.	10.93	26.73	132.43	105.03	85.47	46.45	67.18	74.23	SDV, VS SLD
413616	0	25	7	0	32	40	71	111	143	COUNT, VS SLD
	.	64.76	67.43	.	64.87	36.67	88.28	69.68	68.61	MEAN, VS SLD
	.	10.00	26.00	.	10.00	5.00	8.00	5.00	5.00	MIN, VS SLD
	.	190.00	82.00	.	190.00	192.00	632.00	632.00	632.00	MAX, VS SLD
	.	44.84	19.72	.	41.47	47.63	97.59	86.52	79.60	SDV, VS SLD
413625	0	3	2	0	5	7	15	22	27	COUNT, VS SLD
	.	27.33	7.00	.	19.20	12.00	40.53	31.45	29.19	MEAN, VS SLD
	.	23.00	6.00	.	6.00	9.00	8.00	8.00	6.00	MIN, VS SLD
	.	32.00	8.00	.	32.00	20.00	160.00	160.00	160.00	MAX, VS SLD
	.	4.51	1.41	.	11.61	4.16	39.50	35.13	32.27	SDV, VS SLD
663001	60	9	0	0	69	0	33	33	102	COUNT, VS SLD
	18.10	26.22	.	.	19.16	.	61.09	61.09	32.73	MEAN, VS SLD
	2.00	3.00	.	.	2.00	.	7.00	7.00	2.00	MIN, VS SLD
	102.00	110.00	.	.	110.00	.	560.00	560.00	560.00	MAX, VS SLD
	20.20	32.91	.	.	22.11	.	115.08	115.08	70.10	SDV, VS SLD
683089	9	30	0	0	39	23	50	73	112	COUNT, VS SLD
	17.22	32.47	.	.	28.95	51.30	24.36	32.85	31.49	MEAN, VS SLD
	7.00	5.00	.	.	5.00	6.00	2.00	2.00	2.00	MIN, VS SLD
	28.00	116.00	.	.	116.00	180.00	106.00	180.00	180.00	MAX, VS SLD
	8.27	29.07	.	.	26.49	60.44	22.97	40.42	36.10	SDV, VS SLD
683090	0	0	0	0	0	15	11	26	26	COUNT, VS SLD
	.	.	.	.	.	7.73	7.91	7.81	7.81	MEAN, VS SLD
	.	.	.	.	.	1.00	6.00	1.00	1.00	MIN, VS SLD
	.	.	.	.	.	44.00	13.00	44.00	44.00	MAX, VS SLD
	.	.	.	.	.	10.62	2.59	8.11	8.11	SDV, VS SLD
TOTAL	175	170	48	44	437	226	452	678	1115	COUNT, VS SLD
	26.00	46.72	29.25	51.82	37.02	56.95	46.02	49.66	44.71	MEAN, VS SLD
	.01	2.00	3.00	2.00	.01	1.00	1.00	1.00	.01	MIN, VS SLD
	248.00	296.00	104.00	316.00	316.00	325.00	632.00	632.00	632.00	MAX, VS SLD
	34.54	56.62	26.16	93.15	51.73	75.20	63.49	67.76	62.26	SDV, VS SLD

Table II-A-5. Seasonal averages and ranges of pH at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	29	12	9	0	50	4	13	17	67	COUNT, PH
	7.41	6.88	6.97	-	7.20	7.07	6.95	6.98	7.15	MEAN, PH
	7.00	6.70	6.70	-	6.70	6.70	6.60	6.60	6.60	MIN, PH
	8.00	7.00	7.20	-	8.00	7.40	7.50	7.50	8.00	MAX, PH
	.31	.14	.19	-	.36	.33	.35	.34	.36	SDV, PH
413011	28	26	4	0	58	11	11	22	80	COUNT, PH
	7.75	7.57	7.50	-	7.65	7.79	7.45	7.62	7.64	MEAN, PH
	7.40	6.90	7.30	-	6.90	7.60	7.20	7.20	6.90	MIN, PH
	8.10	8.20	7.60	-	8.20	8.20	7.70	8.20	8.20	MAX, PH
	.14	.30	.14	-	.24	.22	.18	.26	.25	SDV, PH
413034	0	0	0	0	0	10	31	41	41	COUNT, PH
	-	-	-	-	-	7.04	6.83	6.88	6.88	MEAN, PH
	-	-	-	-	-	6.60	6.40	6.40	6.40	MIN, PH
	-	-	-	-	-	7.40	7.40	7.40	7.40	MAX, PH
	-	-	-	-	-	.28	.26	.28	.28	SDV, PH
413614	9	29	9	27	74	13	25	38	112	COUNT, PH
	7.78	7.39	7.36	7.18	7.36	7.43	7.42	7.42	7.38	MEAN, PH
	7.50	6.90	7.10	6.80	6.80	7.00	6.90	6.90	6.80	MIN, PH
	8.00	7.90	7.90	7.50	8.00	7.80	8.20	8.20	8.20	MAX, PH
	.17	.29	.25	.24	.31	.27	.34	.35	.32	SDV, PH
413615	0	6	6	7	19	54	40	94	113	COUNT, PH
	-	7.13	6.83	7.04	7.01	7.26	6.93	7.12	7.10	MEAN, PH
	-	6.60	6.50	6.70	6.50	6.80	6.30	6.30	6.30	MIN, PH
	-	7.80	7.30	7.20	7.80	8.40	8.00	8.40	8.40	MAX, PH
	-	.48	.28	.16	.33	.37	.42	.42	.41	SDV, PH
413616	0	25	7	0	32	40	30	70	102	COUNT, PH
	-	7.20	7.33	-	7.23	7.58	7.29	7.45	7.38	MEAN, PH
	-	6.90	7.20	-	6.90	7.00	7.00	7.00	6.90	MIN, PH
	-	7.50	7.40	-	7.50	8.50	8.00	8.50	8.50	MAX, PH
	-	.20	.10	-	.19	.39	.25	.36	.32	SDV, PH
413625	0	3	2	0	5	4	3	7	12	COUNT, PH
	-	7.37	7.35	-	7.36	7.65	7.20	7.46	7.42	MEAN, PH
	-	7.30	7.30	-	7.30	7.20	6.90	6.90	6.90	MIN, PH
	-	7.50	7.40	-	7.50	7.90	7.50	7.90	7.90	MAX, PH
	-	.12	.07	-	.09	.31	.30	.37	.28	SDV, PH
463001	38	5	0	0	43	0	8	8	51	COUNT, PH
	7.80	7.86	-	-	7.80	-	7.72	7.72	7.79	MEAN, PH
	7.40	7.50	-	-	7.40	-	7.30	7.30	7.30	MIN, PH
	8.30	8.20	-	-	8.30	-	8.00	8.00	8.30	MAX, PH
	.21	.34	-	-	.22	-	.23	.23	.22	SDV, PH
683089	9	30	0	0	39	23	23	46	85	COUNT, PH
	7.26	6.89	-	-	6.97	7.44	6.91	7.17	7.08	MEAN, PH
	6.80	6.60	-	-	6.60	6.70	6.60	6.60	6.60	MIN, PH
	8.30	8.10	-	-	8.30	8.10	7.30	8.10	8.30	MAX, PH
	.53	.44	-	-	.48	.38	.22	.41	.45	SDV, PH
683090	0	0	0	0	0	15	4	19	19	COUNT, PH
	-	-	-	-	-	7.63	7.10	7.52	7.52	MEAN, PH
	-	-	-	-	-	7.20	7.00	7.00	7.00	MIN, PH
	-	-	-	-	-	8.10	7.20	8.10	8.10	MAX, PH
	-	-	-	-	-	.25	.12	.32	.32	SDV, PH
TOTAL	113	136	37	34	320	174	188	362	682	COUNT, PH
	7.64	7.24	7.19	7.15	7.37	7.43	7.11	7.26	7.31	MEAN, PH
	6.80	6.60	6.50	6.70	6.50	6.60	6.30	6.30	6.30	MIN, PH
	8.30	8.20	7.90	7.50	8.30	8.50	8.20	8.50	8.50	MAX, PH
	.32	.42	.30	.23	.41	.38	.40	.42	.42	SDV, PH

Table II-A-6. Seasonal averages and ranges of alkalinity (as $CaCO_3$) at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	37	15	9	0	61	4	17	21	82	COUNT, T ALK
	81.84	71.73	36.22	-	72.62	51.50	55.65	54.86	68.07	MEAN, T ALK
	27.00	26.00	20.00	-	20.00	32.00	30.00	30.00	20.00	MIN, T ALK
	256.00	190.00	60.00	-	256.00	68.00	98.00	98.00	256.00	MAX, T ALK
	63.69	55.31	17.33	-	58.46	16.21	21.73	20.74	51.94	SDV, T ALK
413011	36	26	4	0	66	11	18	29	95	COUNT, T ALK
	117.97	100.15	61.00	-	107.50	132.36	78.94	87.63	101.06	MEAN, T ALK
	56.00	56.00	46.00	-	46.00	70.00	56.00	56.00	46.00	MIN, T ALK
	220.00	210.00	106.00	-	220.00	202.00	112.00	202.00	220.00	MAX, T ALK
	44.45	39.72	30.13	-	43.91	39.28	17.79	27.76	40.57	SDV, T ALK
413036	0	0	0	0	0	10	36	46	46	COUNT, T ALK
	-	-	-	-	-	74.10	44.11	50.63	50.63	MEAN, T ALK
	-	-	-	-	-	32.00	20.00	20.00	20.00	MIN, T ALK
	-	-	-	-	-	150.00	100.00	150.00	150.00	MAX, T ALK
	-	-	-	-	-	34.43	16.02	24.35	24.35	SDV, T ALK
413414	9	33	9	27	78	13	66	79	157	COUNT, T ALK
	153.89	145.88	87.56	81.37	110.82	107.85	120.48	120.81	115.12	MEAN, T ALK
	86.00	58.00	66.00	66.00	66.00	63.00	40.00	40.00	40.00	MIN, T ALK
	332.00	534.00	222.00	92.00	534.00	221.00	268.00	268.00	534.00	MAX, T ALK
	85.15	103.19	55.90	15.22	85.09	43.62	64.22	60.35	75.35	SDV, T ALK
413615	0	6	6	7	19	54	80	134	153	COUNT, T ALK
	-	65.67	50.67	72.00	63.26	49.02	69.11	57.13	57.90	MEAN, T ALK
	-	36.00	22.00	62.00	22.00	26.00	12.00	12.00	12.00	MIN, T ALK
	-	152.00	106.00	92.00	152.00	222.00	236.00	236.00	236.00	MAX, T ALK
	-	44.19	32.06	9.45	30.41	46.29	40.63	43.63	42.49	SDV, T ALK
413616	0	25	7	0	32	40	56	96	128	COUNT, T ALK
	-	71.44	87.14	-	74.87	107.67	89.56	97.09	91.54	MEAN, T ALK
	-	46.00	80.00	-	46.00	76.00	56.00	56.00	46.00	MIN, T ALK
	-	120.00	96.00	-	120.00	186.00	130.00	186.00	186.00	MAX, T ALK
	-	17.20	5.98	-	16.72	24.50	19.03	22.76	23.62	SDV, T ALK
413625	0	3	2	0	5	7	8	15	20	COUNT, T ALK
	-	61.33	31.00	-	49.20	150.00	68.50	106.53	92.20	MEAN, T ALK
	-	40.00	30.00	-	30.00	56.00	30.00	30.00	30.00	MIN, T ALK
	-	78.00	32.00	-	78.00	180.00	108.00	180.00	180.00	MAX, T ALK
	-	19.63	1.41	-	21.57	44.69	23.15	53.61	53.67	SDV, T ALK
463001	45	9	0	0	54	0	13	13	67	COUNT, T ALK
	190.93	210.22	-	-	194.15	-	145.23	145.23	184.66	MEAN, T ALK
	100.00	160.00	-	-	100.00	-	62.00	62.00	62.00	MIN, T ALK
	239.00	268.00	-	-	268.00	-	208.00	208.00	268.00	MAX, T ALK
	37.86	50.64	-	-	41.15	-	46.46	46.46	46.98	SDV, T ALK
483099	8	30	0	0	38	23	47	70	108	COUNT, T ALK
	87.11	49.87	-	-	57.69	71.00	38.64	49.27	52.28	MEAN, T ALK
	23.00	12.00	-	-	12.00	22.00	12.00	12.00	12.00	MIN, T ALK
	280.00	278.00	-	-	280.00	220.00	252.00	252.00	280.00	MAX, T ALK
	108.05	70.38	-	-	80.65	49.96	40.81	44.64	59.64	SDV, T ALK
483098	0	0	0	0	0	15	4	19	19	COUNT, T ALK
	-	-	-	-	-	110.20	52.50	101.21	101.21	MEAN, T ALK
	-	-	-	-	-	88.00	42.00	42.00	42.00	MIN, T ALK
	-	-	-	-	-	154.00	58.00	154.00	154.00	MAX, T ALK
	-	-	-	-	-	15.35	7.19	29.32	29.32	SDV, T ALK
TOTAL	136	147	37	34	354	177	345	522	876	COUNT, T ALK
	132.62	96.71	63.08	79.44	103.81	89.96	71.03	77.67	88.48	MEAN, T ALK
	23.00	12.00	20.00	62.00	12.00	22.00	12.00	12.00	12.00	MIN, T ALK
	332.00	534.00	222.00	92.00	534.00	222.00	268.00	268.00	534.00	MAX, T ALK
	72.38	78.95	30.00	14.75	73.62	43.86	49.86	44.63	61.59	SDV, T ALK

Table II-A-7. Seasonal averages and ranges of hardness (as $CaCO_3$) at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	36	8	9	0	53	0	17	17	70	COUNT, T HARD
	144.31	66.25	67.33	-	119.46	-	68.94	68.94	107.19	MEAN, T HARD
	28.00	48.00	23.00	-	23.00	-	30.00	30.00	23.00	MIN, T HARD
	520.00	222.00	56.00	-	520.00	-	145.00	145.00	520.00	MAX, T HARD
	130.71	58.08	25.63	-	121.19	-	33.26	33.26	108.03	SDV, T HARD
413011	36	15	4	0	55	0	20	20	75	COUNT, T HARD
	190.08	104.27	84.25	-	165.40	-	110.15	110.15	144.60	MEAN, T HARD
	74.00	92.00	53.00	-	53.00	-	65.00	65.00	53.00	MIN, T HARD
	405.00	388.00	170.00	-	405.00	-	196.00	196.00	405.00	MAX, T HARD
	94.38	102.73	56.11	-	97.68	-	40.97	40.97	91.64	SDV, T HARD
413036	0	0	0	0	0	10	36	46	46	COUNT, T HARD
	-	-	-	-	-	167.20	61.86	85.01	85.01	MEAN, T HARD
	-	-	-	-	-	70.00	36.00	36.00	36.00	MIN, T HARD
	-	-	-	-	-	296.00	150.00	296.00	296.00	MAX, T HARD
	-	-	-	-	-	80.65	25.00	55.36	55.36	SDV, T HARD
413619	0	26	9	27	62	13	46	59	121	COUNT, T HARD
	-	188.04	156.22	139.61	155.52	154.38	158.15	156.70	156.08	MEAN, T HARD
	-	57.00	86.00	65.00	57.00	88.00	52.00	52.00	52.00	MIN, T HARD
	-	610.00	272.00	200.00	610.00	352.00	330.00	352.00	610.00	MAX, T HARD
	-	118.75	66.76	40.20	85.81	76.09	83.25	81.09	83.19	SDV, T HARD
413615	0	2	6	7	15	54	86	140	155	COUNT, T HARD
	-	95.50	119.67	156.43	129.67	156.22	82.77	111.10	112.80	MEAN, T HARD
	-	82.00	95.00	120.00	82.00	50.00	20.00	20.00	20.00	MIN, T HARD
	-	109.00	252.00	220.00	252.00	705.00	500.00	705.00	705.00	MAX, T HARD
	-	19.09	65.06	33.12	51.99	136.73	60.33	113.93	109.69	SDV, T HARD
413616	0	25	7	0	32	38	61	99	131	COUNT, T HARD
	-	322.88	314.00	-	320.96	244.76	268.36	259.10	274.21	MEAN, T HARD
	-	35.00	286.00	-	35.00	150.00	150.00	150.00	35.00	MIN, T HARD
	-	455.00	325.00	-	455.00	352.00	380.00	380.00	455.00	MAX, T HARD
	-	70.92	9.16	-	62.37	44.53	60.57	55.07	63.23	SDV, T HARD
413625	0	3	0	0	3	6	15	21	24	COUNT, T HARD
	-	66.67	-	-	66.67	290.00	101.93	157.38	145.70	MEAN, T HARD
	-	40.00	-	-	40.00	250.00	35.00	35.00	35.00	MIN, T HARD
	-	89.00	-	-	89.00	310.00	214.00	310.00	310.00	MAX, T HARD
	-	22.81	-	-	22.81	26.07	60.11	88.80	97.62	SDV, T HARD
463001	43	6	0	0	49	0	12	12	61	COUNT, T HARD
	350.53	336.00	-	-	348.76	-	200.17	200.17	316.15	MEAN, T HARD
	184.00	248.00	-	-	184.00	-	121.00	121.00	121.00	MIN, T HARD
	480.00	396.00	-	-	480.00	-	405.00	405.00	480.00	MAX, T HARD
	94.51	62.10	-	-	91.00	-	100.82	100.82	93.93	SDV, T HARD
683089	0	15	0	0	15	23	47	70	85	COUNT, T HARD
	-	135.27	-	-	135.27	150.04	71.80	97.60	98.78	MEAN, T HARD
	-	24.00	-	-	24.00	36.00	22.00	22.00	22.00	MIN, T HARD
	-	605.00	-	-	605.00	550.00	470.00	550.00	605.00	MAX, T HARD
	-	152.65	-	-	152.64	120.08	67.26	104.73	115.07	SDV, T HARD
683090	0	0	0	0	0	8	11	19	19	COUNT, T HARD
	-	-	-	-	-	179.25	75.73	119.32	119.32	MEAN, T HARD
	-	-	-	-	-	136.00	51.00	51.00	51.00	MIN, T HARD
	-	-	-	-	-	228.00	106.00	228.00	228.00	MAX, T HARD
	-	-	-	-	-	32.88	16.79	57.75	57.75	SDV, T HARD
TOTAL	119	100	29	36	284	152	351	503	787	COUNT, T HARD
	201.18	203.70	138.66	142.63	193.41	183.67	129.25	145.68	166.50	MEAN, T HARD
	28.00	24.00	23.00	65.00	23.00	36.00	20.00	20.00	20.00	MIN, T HARD
	520.00	610.00	325.00	220.00	610.00	705.00	500.00	705.00	705.00	MAX, T HARD
	140.98	130.27	105.98	50.84	131.90	109.75	100.66	108.01	120.67	SDV, T HARD

Table II-4-8. Seasonal averages and ranges of concentrations of total phosphorus at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	46	51	11	0	108	7	65	2	74	182	COUNT, T PHOS
	.315	.425	.400	.	.305	1.081	.390	.305	.450	.427	MEAN, T PHOS
	.050	.130	.100	.	.050	.230	.160	.240	.160	.050	MIN, T PHOS
	1.730	4.600	.910	.	4.600	2.360	1.840	.600	2.360	4.600	MAX, T PHOS
	.244	.446	.244	.	.347	.740	.200	.078	.370	.363	SDV, T PHOS
413011	51	33	10	0	94	49	107	0	156	250	COUNT, T PHOS
	.245	.225	.131	.	.215	.103	.276	.	.193	.212	MEAN, T PHOS
	.050	.080	.070	.	.050	.030	.010	.	.010	.010	MIN, T PHOS
	1.500	.900	.380	.	1.500	.450	1.040	.	1.040	1.500	MAX, T PHOS
	.248	.173	.090	.	.213	.121	.213	.	.193	.200	SDV, T PHOS
413034	0	0	0	0	0	10	50	7	67	67	COUNT, T PHOS
	.	.	.	.	.	1.018	.155	.900	.430	.430	MEAN, T PHOS
	.	.	.	.	.	.300	.040	.770	.040	.040	MIN, T PHOS
	.	.	.	.	.	5.600	.670	1.300	5.600	5.600	MAX, T PHOS
	.	.	.	.	.	1.530	.071	.221	.753	.753	SDV, T PHOS
413414	9	33	4	27	73	13	56	3	72	145	COUNT, T PHOS
	.207	.415	.172	.353	.344	.313	.176	.167	.215	.345	MEAN, T PHOS
	.083	.070	.140	.200	.070	.060	.020	.080	.020	.020	MIN, T PHOS
	.610	2.200	.680	.960	2.200	1.050	2.320	.250	2.320	2.320	MAX, T PHOS
	.125	.413	.190	.156	.357	.366	.328	.105	.329	.337	SDV, T PHOS
413415	0	9	6	17	32	62	110	11	183	215	COUNT, T PHOS
	.	.177	.447	.442	.440	.400	.305	.260	.375	.415	MEAN, T PHOS
	.	.120	.360	.300	.120	.060	.040	.070	.040	.040	MIN, T PHOS
	.	.250	1.100	1.420	1.420	1.430	.920	.780	1.430	1.430	MAX, T PHOS
	.	.066	.290	.303	.417	.375	.175	.260	.270	.317	SDV, T PHOS
413416	0	25	7	0	32	65	66	0	128	160	COUNT, T PHOS
	.	1.427	1.180	.	1.373	.924	.686	.	.814	1.022	MEAN, T PHOS
	.	.770	.870	.	.770	.360	.090	.	.090	.090	MIN, T PHOS
	.	2.800	2.000	.	2.800	3.360	5.550	.	5.550	5.550	MAX, T PHOS
	.	.549	.543	.	.560	.648	.787	.	.769	.730	SDV, T PHOS
413425	0	3	2	0	5	7	30	7	44	49	COUNT, T PHOS
	.	.570	.445	.	.480	.193	.362	.223	.312	.328	MEAN, T PHOS
	.	.400	.370	.	.370	.110	.130	.140	.110	.110	MIN, T PHOS
	.	.670	.520	.	.670	.560	.940	.280	.940	.940	MAX, T PHOS
	.	.148	.035	.	.184	.166	.231	.050	.213	.215	SDV, T PHOS
463001	62	9	0	0	68	0	52	9	61	130	COUNT, T PHOS
	.263	.354	.	.	.275	.	.720	.330	.603	.457	MEAN, T PHOS
	.070	.100	.	.	.070	.	.020	.070	.020	.020	MIN, T PHOS
	.920	.900	.	.	.920	.	5.000	.600	5.000	5.000	MAX, T PHOS
	.220	.259	.	.	.232	.	1.004	.184	.940	.691	SDV, T PHOS
483009	9	30	0	0	39	23	80	5	108	147	COUNT, T PHOS
	.172	.287	.	.	.260	.400	.425	.344	.396	.357	MEAN, T PHOS
	.077	.083	.	.	.077	.040	.020	.060	.020	.020	MIN, T PHOS
	.350	.830	.	.	.830	2.330	3.940	.800	3.940	3.940	MAX, T PHOS
	.058	.205	.	.	.187	.543	.080	.017	.483	.424	SDV, T PHOS
483090	0	0	0	0	0	15	22	6	43	43	COUNT, T PHOS
	.	.	.	.	.	.229	.456	.323	.308	.308	MEAN, T PHOS
	.	.	.	.	.	.150	.330	.250	.150	.150	MIN, T PHOS
	.	.	.	.	.	.460	.690	.410	.690	.690	MAX, T PHOS
	.	.	.	.	.	.078	.103	.076	.137	.137	SDV, T PHOS
TOTAL	175	170	48	44	438	226	605	33	936	1374	COUNT, T PHOS
	.278	.409	.578	.344	.405	.512	.393	.362	.427	.431	MEAN, T PHOS
	.050	.070	.070	.200	.050	.030	.010	.060	.010	.010	MIN, T PHOS
	1.510	4.600	2.000	1.420	4.600	5.600	5.550	1.300	5.600	5.600	MAX, T PHOS
	.236	.404	.427	.160	.311	.614	.534	.310	.567	.536	SDV, T PHOS

Table II-A-9. Seasonal averages and ranges of concentrations of soluble phosphorus at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Table II-6-20. Seasonal averages and ranges of concentrations of total organic nitrogen at the predominantly single land use monitoring sites

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Table II-A-11. Seasonal averages and ranges of concentrations of ammonia nitrogen at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	46	31	11	0	88	7	47	54	142	COUNT, NH3-N
	.33	.19	.15	-	.26	.15	.08	.09	.19	MEAN, NH3-N
	.07	.01	.01	-	.01	.01	.01	.01	.01	MIN, NH3-N
	.79	1.00	.80	-	1.00	.40	.43	.43	1.00	MAX, NH3-N
	.21	.23	.22	-	.23	.15	.09	.10	.21	SDV, NH3-N
413011	51	33	14	0	98	49	76	125	223	COUNT, NH3-N
	.30	.24	.05	-	.24	.21	.11	.15	.19	MEAN, NH3-N
	.10	.02	.02	-	.02	.03	.01	.01	.01	MIN, NH3-N
	.79	2.00	.14	-	2.00	.72	.91	.91	2.00	MAX, NH3-N
	.15	.34	.08	-	.24	.14	.16	.16	.20	SDV, NH3-N
413034	0	0	0	0	0	10	37	47	47	COUNT, NH3-N
	-	-	-	-	-	.27	.19	.21	.21	MEAN, NH3-N
	-	-	-	-	-	.07	.01	.01	.01	MIN, NH3-N
	-	-	-	-	-	.49	1.60	1.60	1.60	MAX, NH3-N
	-	-	-	-	-	.14	.28	.26	.26	SDV, NH3-N
413614	9	33	9	27	78	13	56	69	147	COUNT, NH3-N
	.50	.27	.51	.69	.47	.22	.06	.09	.29	MEAN, NH3-N
	.06	.02	.15	.15	.02	.02	.01	.01	.01	MIN, NH3-N
	1.20	.61	.77	1.40	1.40	.65	.25	.65	1.40	MAX, NH3-N
	.42	.19	.20	.23	.30	.20	.05	.12	.30	SDV, NH3-N
413615	0	6	6	17	29	62	94	156	185	COUNT, NH3-N
	-	.89	1.21	1.23	1.07	.49	.24	.34	.45	MEAN, NH3-N
	-	.37	.98	.79	.37	.06	.01	.01	.01	MIN, NH3-N
	-	.57	1.50	2.00	2.00	1.30	.87	1.30	2.00	MAX, NH3-N
	-	.08	.20	.37	.42	.28	.19	.26	.40	SDV, NH3-N
413616	0	25	7	0	32	40	74	114	146	COUNT, NH3-N
	-	.10	.03	-	.08	.10	.06	.08	.08	MEAN, NH3-N
	-	.02	.01	-	.01	.01	.01	.01	.01	MIN, NH3-N
	-	.18	.09	-	.18	.37	.33	.37	.37	MAX, NH3-N
	-	.06	.03	-	.06	.10	.07	.08	.08	SDV, NH3-N
413625	0	3	2	0	5	7	15	22	27	COUNT, NH3-N
	-	.05	.07	-	.06	.09	.16	.14	.13	MEAN, NH3-N
	-	.01	.07	-	.01	.03	.02	.02	.01	MIN, NH3-N
	-	.08	.08	-	.08	.24	.46	.46	.46	MAX, NH3-N
	-	.04	.01	-	.03	.08	.15	.13	.12	SDV, NH3-N
463001	60	9	0	0	69	0	44	44	113	COUNT, NH3-N
	.21	.19	-	-	.21	-	.48	.48	.32	MEAN, NH3-N
	.06	.04	-	-	.04	-	.02	.02	.02	MIN, NH3-N
	.96	.43	-	-	.96	-	2.80	2.80	2.80	MAX, NH3-N
	.17	.11	-	-	.16	-	.59	.59	.41	SDV, NH3-N
483089	9	30	0	0	39	23	55	78	117	COUNT, NH3-N
	.15	.28	-	-	.25	.34	.21	.25	.25	MEAN, NH3-N
	.07	.01	-	-	.01	.03	.01	.01	.01	MIN, NH3-N
	.25	1.00	-	-	1.00	1.03	.92	1.03	1.03	MAX, NH3-N
	.05	.26	-	-	.24	.29	.21	.24	.24	SDV, NH3-N
483090	0	0	0	0	0	15	11	26	26	COUNT, NH3-N
	-	-	-	-	-	.08	.16	.12	.12	MEAN, NH3-N
	-	-	-	-	-	.02	.08	.02	.02	MIN, NH3-N
	-	-	-	-	-	.26	.23	.26	.26	MAX, NH3-N
	-	-	-	-	-	.07	.05	.07	.07	SDV, NH3-N
TOTAL	175	170	49	44	438	226	509	735	1173	COUNT, NH3-N
	.28	.23	.30	.90	.32	.27	.17	.20	.25	MEAN, NH3-N
	.06	.01	.01	.15	.01	.01	.01	.01	.01	MIN, NH3-N
	1.20	2.00	1.50	2.00	2.00	1.30	2.80	2.80	2.80	MAX, NH3-N
	.28	.24	.41	.39	.33	.25	.26	.26	.29	SDV, NH3-N

Table II-A-12. Seasonal averages and ranges of concentrations of nitrate plus nitrite nitrogen at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	46	31	11	0	88	7	47	54	142	COUNT, NO2NO3
	1.01	.52	.94	.	.83	1.09	.67	.73	.79	MEAN, NO2NO3
	.30	.02	.01	.	.01	.25	.12	.12	.01	MIN, NO2NO3
	4.00	1.99	2.50	.	4.00	2.10	1.39	2.10	4.00	MAX, NO2NO3
	.68	.41	.78	.	.65	.78	.29	.40	.57	SDV, NO2NO3
413011	51	33	14	0	98	49	76	125	223	COUNT, NO2NO3
	.78	.90	.30	.	.75	1.16	.58	.81	.78	MEAN, NO2NO3
	.36	.29	.09	.	.09	.63	.16	.16	.09	MIN, NO2NO3
	1.47	2.50	1.20	.	2.50	2.20	1.99	2.20	2.50	MAX, NO2NO3
	.27	.55	.28	.	.43	.47	.28	.46	.45	SDV, NO2NO3
413034	0	0	0	0	0	10	37	47	47	COUNT, NO2NO3
	.	.	.	.	.	2.20	.93	1.20	1.20	MEAN, NO2NO3
	.	.	.	.	.	1.21	.39	.39	.39	MIN, NO2NO3
	.	.	.	.	.	3.30	2.50	3.30	3.30	MAX, NO2NO3
	.	.	.	.	.	.66	.54	.77	.77	SDV, NO2NO3
413614	9	33	9	27	78	13	56	69	147	COUNT, NO2NO3
	1.47	1.10	1.77	1.09	1.21	1.00	.73	.78	1.01	MEAN, NO2NO3
	.46	.16	.25	.95	.16	.03	.01	.01	.01	MIN, NO2NO3
	2.70	2.50	3.40	1.30	3.40	2.20	1.40	2.20	3.40	MAX, NO2NO3
	.65	.68	.91	.12	.61	.76	.29	.42	.57	SDV, NO2NO3
413615	0	6	6	17	29	62	94	156	185	COUNT, NO2NO3
	.	2.70	3.48	1.61	2.34	1.78	1.23	1.45	1.59	MEAN, NO2NO3
	.	1.92	2.30	1.25	1.25	.24	.33	.24	.24	MIN, NO2NO3
	.	4.30	5.40	2.70	5.40	6.80	3.90	6.80	6.80	MAX, NO2NO3
	.	.88	1.21	.51	1.02	1.20	.78	1.01	1.06	SDV, NO2NO3
413616	0	25	7	0	32	40	74	114	146	COUNT, NO2NO3
	.	.71	.53	.	.67	.58	.47	.51	.54	MEAN, NO2NO3
	.	.25	.14	.	.14	.16	.01	.01	.01	MIN, NO2NO3
	.	1.80	.97	.	1.80	1.04	5.20	5.20	5.20	MAX, NO2NO3
	.	.33	.29	.	.33	.26	.61	.51	.48	SDV, NO2NO3
413625	0	3	2	0	5	7	15	22	27	COUNT, NO2NO3
	.	.78	.56	.	.69	.52	.57	.55	.58	MEAN, NO2NO3
	.	.61	.54	.	.54	.28	.09	.09	.09	MIN, NO2NO3
	.	.88	.58	.	.88	.89	1.44	1.44	1.44	MAX, NO2NO3
	.	.15	.03	.	.16	.22	.29	.27	.25	SDV, NO2NO3
463001	60	9	0	0	69	0	44	44	113	COUNT, NO2NO3
	4.56	2.70	.	.	4.30	.	3.04	3.04	3.81	MEAN, NO2NO3
	1.63	1.01	.	.	1.01	.	.28	.28	.28	MIN, NO2NO3
	8.22	9.30	.	.	9.30	.	10.80	10.80	10.80	MAX, NO2NO3
	1.87	2.60	.	.	2.06	.	2.03	2.03	2.13	SDV, NO2NO3
683089	9	30	0	0	39	23	55	78	117	COUNT, NO2NO3
	1.64	1.06	.	.	1.19	1.26	.77	.91	1.01	MEAN, NO2NO3
	.81	.49	.	.	.49	.11	.19	.11	.11	MIN, NO2NO3
	2.30	2.70	.	.	2.70	2.70	3.00	3.00	3.00	MAX, NO2NO3
	.60	.59	.	.	.64	.76	.66	.60	.63	SDV, NO2NO3
683090	0	0	0	0	0	15	11	26	26	COUNT, NO2NO3
	.	.	.	.	.	.83	.53	.70	.70	MEAN, NO2NO3
	.	.	.	.	.	.49	.28	.28	.28	MIN, NO2NO3
	.	.	.	.	.	1.51	.74	1.51	1.51	MAX, NO2NO3
	.	.	.	.	.	.30	.14	.28	.28	SDV, NO2NO3
TOTAL	175	170	49	44	438	226	509	735	1173	COUNT, NO2NO3
	2.21	1.02	1.15	1.37	1.55	1.23	.97	1.05	1.23	MEAN, NO2NO3
	.30	.02	.01	.95	.01	.03	.01	.01	.01	MIN, NO2NO3
	8.22	9.30	5.40	2.70	9.30	6.80	10.80	10.80	10.80	MAX, NO2NO3
	2.07	.95	1.22	.48	1.59	.90	1.03	1.00	1.28	SDV, NO2NO3

Table II-A-13. Seasonal averages and ranges of concentrations of total organic carbon at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	37	25	8	0	70	3	17	20	90	COUNT, TOC
	18.91	47.78	14.44	-	28.71	49.17	24.06	27.82	28.51	MEAN, TOC
	4.00	8.00	4.00	-	4.00	19.50	10.00	10.00	4.00	MIN, TOC
	94.50	215.50	33.50	-	215.50	101.00	47.00	101.00	215.50	MAX, TOC
	19.79	57.84	11.56	-	39.90	45.05	12.69	20.83	36.43	SDV, TOC
413011	38	30	14	0	82	15	20	35	117	COUNT, TOC
	11.03	12.75	7.36	-	11.03	11.20	9.67	10.33	10.82	MEAN, TOC
	6.00	5.00	3.00	-	3.00	7.00	5.50	5.50	3.00	MIN, TOC
	34.50	26.00	11.00	-	34.50	21.50	25.00	25.00	34.50	MAX, TOC
	5.82	5.08	2.22	-	5.19	3.66	4.22	4.01	4.86	SDV, TOC
413036	0	0	0	0	0	4	15	19	19	COUNT, TOC
	-	-	-	-	-	69.25	17.17	28.13	28.13	MEAN, TOC
	-	-	-	-	-	59.00	10.00	10.00	10.00	MIN, TOC
	-	-	-	-	-	82.00	29.50	82.00	82.00	MAX, TOC
	-	-	-	-	-	12.01	5.13	22.81	22.81	SDV, TOC
413614	9	33	9	27	78	6	32	38	116	COUNT, TOC
	13.11	22.15	17.78	37.11	25.78	32.58	12.81	15.77	22.50	MEAN, TOC
	5.50	2.50	3.00	22.00	2.50	8.00	3.50	3.50	2.50	MIN, TOC
	37.00	68.50	32.50	72.00	72.00	64.50	28.50	64.50	72.00	MAX, TOC
	9.65	17.21	10.39	17.34	17.95	21.07	5.91	11.98	16.86	SDV, TOC
413615	0	2	6	17	25	32	41	73	98	COUNT, TOC
	-	48.75	50.42	93.26	79.42	51.48	28.41	38.53	48.96	MEAN, TOC
	-	44.00	23.00	26.50	23.00	14.00	7.00	7.00	7.00	MIN, TOC
	-	53.50	102.50	194.00	194.00	121.00	86.50	121.00	194.00	MAX, TOC
	-	6.72	32.09	71.86	63.90	29.65	18.12	26.34	42.97	SDV, TOC
413616	0	25	7	0	32	18	27	45	77	COUNT, TOC
	-	36.90	25.36	-	34.38	27.11	30.92	29.40	31.47	MEAN, TOC
	-	5.50	17.00	-	5.50	10.00	7.00	7.00	5.50	MIN, TOC
	-	109.00	34.50	-	109.00	134.00	102.50	134.00	134.00	MAX, TOC
	-	31.86	6.91	-	28.61	27.44	25.87	26.03	27.06	SDV, TOC
413625	0	3	2	0	5	5	7	12	17	COUNT, TOC
	-	13.13	8.25	-	11.18	11.80	18.00	15.42	14.17	MEAN, TOC
	-	9.50	8.00	-	8.00	9.50	8.50	8.50	8.00	MIN, TOC
	-	15.40	8.50	-	15.40	15.00	41.00	41.00	41.00	MAX, TOC
	-	3.18	.35	-	3.50	2.36	11.91	9.46	8.28	SDV, TOC
463001	45	9	0	0	54	0	14	14	68	COUNT, TOC
	14.63	11.50	-	-	14.11	-	26.07	26.07	16.57	MEAN, TOC
	9.00	2.50	-	-	2.50	-	14.50	14.50	2.50	MIN, TOC
	25.00	21.50	-	-	25.00	-	73.00	73.00	73.00	MAX, TOC
	2.85	6.68	-	-	3.86	-	16.07	16.07	9.25	SDV, TOC
683089	9	30	0	0	39	13	30	43	82	COUNT, TOC
	11.89	22.95	-	-	20.40	31.15	21.73	24.58	22.59	MEAN, TOC
	5.50	5.50	-	-	5.50	10.50	4.50	4.50	4.50	MIN, TOC
	17.50	62.50	-	-	62.50	77.00	79.50	79.50	79.50	MAX, TOC
	3.89	17.94	-	-	16.46	25.41	17.85	20.58	18.74	SDV, TOC
683090	0	0	0	0	0	6	7	13	13	COUNT, TOC
	-	-	-	-	-	14.92	14.14	14.50	14.50	MEAN, TOC
	-	-	-	-	-	12.00	10.00	10.00	10.00	MIN, TOC
	-	-	-	-	-	20.50	19.50	20.50	20.50	MAX, TOC
	-	-	-	-	-	3.02	3.44	3.14	3.14	SDV, TOC
TOTAL	138	157	46	44	385	102	210	312	697	COUNT, TOC
	14.51	26.49	19.02	58.81	25.00	34.09	21.45	25.58	25.26	MEAN, TOC
	4.00	2.50	3.00	22.00	2.50	7.00	3.50	3.50	2.50	MIN, TOC
	94.50	215.50	102.50	194.00	215.50	134.00	102.50	134.00	215.50	MAX, TOC
	11.35	30.92	18.75	53.55	31.18	28.77	16.76	22.20	27.51	SDV, TOC

Table II-A-14. Seasonal averages and ranges of concentrations of chloride at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	46	31	9	0	86	7	38	45	131	COUNT, CHLRID
	407,37	9,58	6,44	-	222,02	101,14	22,29	34,56	157,63	MEAN, CHLRID
	6,00	1,00	1,00	-	1,00	19,00	3,00	3,00	1,00	MIN, CHLRID
	1400,00	55,00	14,00	-	1400,00	185,00	120,00	185,00	1400,00	MAX, CHLRID
	452,38	10,23	5,39	-	385,17	69,68	23,65	44,36	325,04	SDV, CHLRID
413011	51	33	4	0	88	48	68	116	204	COUNT, CHLRID
	254,20	57,58	27,75	-	170,17	209,92	54,82	119,00	141,07	MEAN, CHLRID
	30,00	12,00	12,00	-	12,00	60,00	8,00	8,00	8,00	MIN, CHLRID
	1050,00	150,00	64,00	-	1050,00	650,00	160,00	650,00	1050,00	MAX, CHLRID
	235,68	36,26	24,34	-	205,69	121,42	28,40	111,27	160,60	SDV, CHLRID
413034	0	0	0	0	0	10	37	47	47	COUNT, CHLRID
	-	-	-	-	-	137,90	14,86	41,04	41,04	MEAN, CHLRID
	-	-	-	-	-	16,00	2,00	2,00	2,00	MIN, CHLRID
	-	-	-	-	-	675,00	60,00	675,00	675,00	MAX, CHLRID
	-	-	-	-	-	200,70	11,21	102,81	102,81	SDV, CHLRID
413614	9	33	9	27	78	13	56	69	147	COUNT, CHLRID
	61,67	54,94	38,78	372,59	163,81	69,15	50,25	53,81	112,18	MEAN, CHLRID
	14,00	6,00	5,00	95,00	5,00	12,00	2,00	2,00	2,00	MIN, CHLRID
	190,00	290,00	64,00	900,00	900,00	275,00	270,00	275,00	900,00	MAX, CHLRID
	54,07	60,14	23,87	193,91	194,87	88,37	62,93	68,09	158,81	SDV, CHLRID
413615	0	6	6	17	29	62	94	156	185	COUNT, CHLRID
	-	69,17	33,83	1177,94	711,83	418,37	51,15	197,10	277,78	MEAN, CHLRID
	-	35,00	11,00	300,00	11,00	32,00	6,00	6,00	6,00	MIN, CHLRID
	-	175,00	95,00	3250,00	3250,00	7000,00	295,00	7000,00	7000,00	MAX, CHLRID
	-	54,81	32,03	797,11	826,27	929,12	60,92	611,93	674,20	SDV, CHLRID
413616	0	25	7	0	32	40	74	114	146	COUNT, CHLRID
	-	37,28	30,86	-	35,87	70,75	38,24	49,65	46,63	MEAN, CHLRID
	-	30,00	30,00	-	30,00	38,00	19,00	19,00	19,00	MIN, CHLRID
	-	45,00	34,00	-	45,00	115,00	58,00	115,00	115,00	MAX, CHLRID
	-	3,47	1,57	-	4,13	21,23	7,57	20,86	19,38	SDV, CHLRID
413625	0	3	2	0	5	7	15	22	27	COUNT, CHLRID
	-	4,00	,75	-	2,70	167,29	30,27	73,86	60,69	MEAN, CHLRID
	-	1,00	,50	-	,50	46,00	3,00	3,00	,50	MIN, CHLRID
	-	7,00	1,00	-	7,00	230,00	83,00	230,00	230,00	MAX, CHLRID
	-	3,00	,35	-	2,77	67,64	20,14	76,45	74,26	SDV, CHLRID
463001	60	9	0	0	69	0	33	33	102	COUNT, CHLRID
	42,12	28,22	-	-	40,30	-	28,88	28,88	36,61	MEAN, CHLRID
	17,00	20,00	-	-	17,00	-	4,00	4,00	4,00	MIN, CHLRID
	65,00	38,00	-	-	65,00	-	60,00	60,00	65,00	MAX, CHLRID
	9,62	6,53	-	-	10,37	-	11,36	11,36	11,92	SDV, CHLRID
683089	9	30	0	0	39	23	55	78	117	COUNT, CHLRID
	106,22	30,03	-	-	47,62	160,57	20,78	62,00	57,21	MEAN, CHLRID
	6,00	,50	-	-	,50	12,00	2,00	2,00	,50	MIN, CHLRID
	440,00	280,00	-	-	440,00	500,00	165,00	500,00	500,00	MAX, CHLRID
	178,24	69,72	-	-	107,03	162,33	34,14	111,63	109,87	SDV, CHLRID
683090	0	0	0	0	0	15	11	26	26	COUNT, CHLRID
	-	-	-	-	-	90,00	27,00	63,35	63,35	MEAN, CHLRID
	-	-	-	-	-	65,00	8,00	8,00	8,00	MIN, CHLRID
	-	-	-	-	-	190,00	70,00	190,00	190,00	MAX, CHLRID
	-	-	-	-	-	31,84	21,28	41,91	41,91	SDV, CHLRID
TOTAL	175	170	37	44	426	225	481	706	1132	COUNT, CHLRID
	204,23	38,38	25,36	683,75	172,04	213,53	38,30	94,15	123,46	MEAN, CHLRID
	6,00	,50	,50	95,00	,50	12,00	2,00	2,00	,50	MIN, CHLRID
	1400,00	290,00	95,00	3250,00	3250,00	7000,00	295,00	7000,00	7000,00	MAX, CHLRID
	304,58	47,22	22,74	645,37	342,94	511,56	41,28	301,64	319,89	SDV, CHLRID

Table II-A-15. Seasonal averages and ranges of concentrations of iron at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	6	61	2	69	78	COUNT, FE
	3,54	37,30	-	-	11,04	18,88	7,52	5,45	8,45	8,75	MEAN, FE
	,48	26,60	-	-	,48	2,20	,80	3,90	,80	,48	MIN, FE
	7,40	48,00	-	-	48,00	45,00	25,70	7,00	45,00	48,00	MAX, FE
	2,37	15,13	-	-	15,95	15,81	6,40	2,19	8,07	9,20	SDV, FE
413011	7	0	0	0	7	54	98	0	152	159	COUNT, FE
	2,91	-	-	-	2,91	4,96	6,84	-	6,17	6,03	MEAN, FE
	1,00	-	-	-	1,00	,40	,20	-	,20	,20	MIN, FE
	6,00	-	-	-	6,00	28,00	88,20	-	88,20	88,20	MAX, FE
	1,92	-	-	-	1,92	5,50	10,77	-	9,27	9,09	SDV, FE
413034	0	0	0	0	0	10	52	7	69	69	COUNT, FE
	-	-	-	-	-	22,81	5,28	14,26	8,73	8,73	MEAN, FE
	-	-	-	-	-	6,10	,60	9,62	,60	,60	MIN, FE
	-	-	-	-	-	38,00	16,30	24,12	38,00	38,00	MAX, FE
	-	-	-	-	-	11,21	4,02	6,61	8,60	8,60	SDV, FE
413614	9	33	9	27	78	22	56	3	81	159	COUNT, FE
	2,13	6,69	2,22	2,60	4,23	3,62	4,81	6,88	4,64	4,44	MEAN, FE
	,80	,36	,50	,03	,03	,70	,10	3,89	,10	,03	MIN, FE
	5,20	23,00	3,60	8,80	23,00	17,00	33,40	13,80	33,40	33,40	MAX, FE
	1,43	7,92	1,20	3,17	5,86	4,08	6,02	4,96	5,55	5,69	SDV, FE
413615	0	6	7	31	44	62	113	11	186	230	COUNT, FE
	-	3,18	5,74	7,97	6,96	12,49	9,67	10,58	10,66	9,95	MEAN, FE
	-	1,70	2,30	,40	,40	,40	1,20	5,20	,40	,40	MIN, FE
	-	4,00	10,20	32,60	32,60	70,10	39,10	27,99	70,10	70,10	MAX, FE
	-	,87	3,09	10,11	8,70	13,55	7,25	8,28	9,89	9,76	SDV, FE
413616	0	25	7	0	32	39	87	0	126	158	COUNT, FE
	-	10,78	12,24	-	11,10	11,55	34,35	-	27,29	24,01	MEAN, FE
	-	2,20	6,20	-	2,20	1,20	1,70	-	1,20	1,20	MIN, FE
	-	20,00	18,40	-	20,00	95,40	587,40	-	587,40	587,40	MAX, FE
	-	6,43	4,86	-	6,08	20,44	82,09	-	69,82	62,70	SDV, FE
413625	0	3	2	2	7	7	30	7	44	51	COUNT, FE
	-	6,67	,80	5,80	4,74	1,61	13,40	4,26	10,07	9,34	MEAN, FE
	-	5,50	,60	3,80	,60	,70	,10	2,10	,10	,10	MIN, FE
	-	8,00	1,00	7,80	8,00	3,40	62,80	6,90	62,80	62,80	MAX, FE
	-	1,26	,28	2,83	3,05	,98	16,10	1,66	14,15	13,30	SDV, FE
463001	9	3	0	0	12	0	43	9	52	64	COUNT, FE
	6,88	2,73	-	-	5,84	-	20,52	3,54	17,58	15,38	MEAN, FE
	,80	2,00	-	-	,80	-	,05	,05	,05	,05	MIN, FE
	27,40	3,30	-	-	27,40	-	305,30	6,60	305,30	305,30	MAX, FE
	9,59	,67	-	-	8,39	-	51,46	2,75	47,16	42,82	SDV, FE
683089	9	31	0	0	40	24	84	5	113	153	COUNT, FE
	1,32	3,94	-	-	3,35	9,90	5,03	3,60	6,00	5,31	MEAN, FE
	,44	,50	-	-	,44	,50	,10	2,60	,10	,10	MIN, FE
	2,40	16,00	-	-	16,00	66,00	17,80	4,90	66,00	66,00	MAX, FE
	,64	3,90	-	-	3,61	15,92	4,08	1,00	8,28	7,43	SDV, FE
683090	0	0	0	0	0	15	22	6	43	43	COUNT, FE
	-	-	-	-	-	1,75	4,02	4,55	3,30	3,30	MEAN, FE
	-	-	-	-	-	,90	1,20	3,40	,90	,90	MIN, FE
	-	-	-	-	-	3,70	8,50	6,10	8,50	8,50	MAX, FE
	-	-	-	-	-	,69	2,26	1,18	2,06	2,06	SDV, FE
TOTAL	41	103	25	60	229	239	646	50	935	1164	COUNT, FE
	3,37	7,13	5,90	5,48	5,89	9,16	11,69	7,21	10,80	9,43	MEAN, FE
	,44	,36	,50	,03	,03	,40	,05	,05	,05	,03	MIN, FE
	27,40	48,00	18,40	32,60	48,00	95,40	587,40	27,99	587,40	587,40	MAX, FE
	4,94	7,87	5,27	7,98	7,30	13,51	34,86	6,17	29,83	27,00	SDV, FE

Table II-A-16. Seasonal averages and ranges of concentrations of aluminum at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	3	2	0	0	5	6	61	2	69	74	COUNT, AL
	.07	3.35	-	-	1.38	5.75	4.50	3.00	4.57	4.35	MEAN, AL
	.05	3.20	-	-	.05	1.90	.30	1.30	.30	.05	MIN, AL
	.09	3.50	-	-	3.50	10.50	15.70	4.70	15.70	15.70	MAX, AL
	.02	.21	-	-	1.80	3.42	3.97	2.40	3.88	3.85	SDV, AL
413011	4	0	0	0	4	53	98	0	151	155	COUNT, AL
	.09	-	-	-	.09	2.35	4.56	-	3.79	3.69	MEAN, AL
	.07	-	-	-	.07	.20	.30	-	.20	.07	MIN, AL
	.13	-	-	-	.13	11.00	46.30	-	46.30	46.30	MAX, AL
	.03	-	-	-	.03	2.54	6.55	-	5.58	5.54	SDV, AL
413034	0	0	0	0	0	10	52	7	69	69	COUNT, AL
	-	-	-	-	-	8.41	2.88	9.04	4.31	4.31	MEAN, AL
	-	-	-	-	-	1.90	.30	4.80	.30	.30	MIN, AL
	-	-	-	-	-	20.00	10.70	12.88	20.00	20.00	MAX, AL
	-	-	-	-	-	6.70	2.65	3.52	4.32	4.32	SDV, AL
413614	9	33	9	27	78	22	56	3	81	159	COUNT, AL
	.25	2.04	1.35	1.77	1.66	2.67	2.03	.55	2.15	1.91	MEAN, AL
	.02	.02	.05	.05	.02	1.00	.05	.10	.05	.02	MIN, AL
	.61	10.50	2.20	5.70	10.50	11.30	17.00	1.00	17.00	17.00	MAX, AL
	.16	2.79	.85	2.19	2.29	2.49	2.58	.45	2.53	2.42	SDV, AL
413615	0	6	7	31	44	62	113	11	186	230	COUNT, AL
	-	2.07	2.40	3.54	3.16	5.75	3.97	8.38	4.82	4.50	MEAN, AL
	-	1.50	1.00	.05	.05	.30	.70	1.30	.30	.05	MIN, AL
	-	2.60	3.60	15.30	15.30	25.70	14.10	20.90	25.70	25.70	MAX, AL
	-	.39	1.02	4.73	4.02	5.67	2.62	8.12	4.45	4.41	SDV, AL
413616	0	25	7	0	32	39	87	0	126	158	COUNT, AL
	-	1.92	1.39	-	1.80	1.92	4.09	-	3.42	3.09	MEAN, AL
	-	.30	.90	-	.30	.30	.30	-	.30	.30	MIN, AL
	-	8.60	2.30	-	8.60	12.90	38.80	-	38.80	38.80	MAX, AL
	-	1.93	.46	-	1.73	2.90	6.15	-	5.44	4.96	SDV, AL
413625	0	3	2	2	7	7	30	7	44	51	COUNT, AL
	-	2.90	.32	3.10	2.22	1.30	8.89	2.23	6.62	6.02	MEAN, AL
	-	2.20	.20	1.40	.20	.60	.70	.70	.60	.20	MIN, AL
	-	3.50	.45	4.80	4.80	2.80	43.00	3.30	43.00	43.00	MAX, AL
	-	.66	.18	2.40	1.67	.84	10.78	.93	9.49	8.95	SDV, AL
463001	4	3	0	0	7	0	43	9	52	59	COUNT, AL
	.04	.60	-	-	.31	-	11.61	2.02	9.95	8.80	MEAN, AL
	.02	.50	-	-	.02	-	.05	.05	.05	.02	MIN, AL
	.08	.82	-	-	.82	-	114.50	4.70	114.50	114.50	MAX, AL
	.03	.16	-	-	.34	-	22.67	1.75	20.81	19.85	SDV, AL
683089	9	31	0	0	40	24	84	5	113	153	COUNT, AL
	.18	.78	-	-	.65	5.95	2.27	.54	2.98	2.37	MEAN, AL
	.02	.05	-	-	.02	.30	.05	.30	.05	.02	MIN, AL
	.26	2.50	-	-	2.50	25.70	15.70	.70	25.70	25.70	MAX, AL
	.10	.58	-	-	.57	8.27	2.40	.22	4.57	4.06	SDV, AL
683090	0	0	0	0	0	15	22	6	43	43	COUNT, AL
	-	-	-	-	-	1.39	2.20	.90	1.73	1.73	MEAN, AL
	-	-	-	-	-	.30	.70	.70	.30	.30	MIN, AL
	-	-	-	-	-	2.50	9.30	1.00	9.30	9.30	MAX, AL
	-	-	-	-	-	.53	1.91	.15	1.48	1.48	SDV, AL
TOTAL	29	103	25	60	217	238	646	50	934	1151	COUNT, AL
	.16	1.65	1.57	2.73	1.74	3.81	4.32	4.09	4.18	3.72	MEAN, AL
	.02	.02	.05	.05	.02	.20	.05	.05	.05	.02	MIN, AL
	.61	10.50	3.60	15.30	15.30	25.70	114.50	20.90	114.50	114.50	MAX, AL
	.13	1.97	.95	3.79	2.54	4.94	7.79	5.28	7.05	6.51	SDV, AL

Table II-A-17. Seasonal averages and ranges of concentrations of silica at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	3	2	0	0	5	6	56	2	64	69	COUNT, SIO2
	6.80	6.20	.	.	6.56	4.05	2.78	4.45	2.95	3.21	MEAN, SIO2
	5.30	4.70	.	.	4.70	2.80	.80	3.70	.80	.80	MIN, SIO2
	7.80	7.70	.	.	7.80	5.00	5.80	5.20	5.80	7.80	MAX, SIO2
	1.32	2.12	.	.	1.45	.88	1.21	1.06	1.25	1.57	SDV, SIO2
413011	3	0	0	0	3	54	83	0	137	140	COUNT, SIO2
	5.37	.	.	.	5.37	4.01	3.03	.	3.65	3.69	MEAN, SIO2
	4.50	.	.	.	4.50	1.30	1.30	.	1.30	1.30	MIN, SIO2
	5.80	.	.	.	5.80	8.40	7.00	.	8.40	8.40	MAX, SIO2
	.75	.	.	.	.75	1.50	1.18	.	1.53	1.53	SDV, SIO2
413034	0	0	0	0	0	10	47	7	64	64	COUNT, SIO2
	.	.	.	.	.	3.51	1.49	8.20	2.54	2.54	MEAN, SIO2
	.	.	.	.	.	1.30	.30	.01	.01	.01	MIN, SIO2
	.	.	.	.	.	9.87	4.90	10.80	10.80	10.80	MAX, SIO2
	.	.	.	.	.	2.41	.96	3.67	2.71	2.71	SDV, SIO2
413014	9	33	9	27	78	22	56	3	81	159	COUNT, SIO2
	5.59	4.09	4.19	4.85	4.88	6.16	4.32	5.50	4.86	4.87	MEAN, SIO2
	3.20	1.50	2.00	3.30	1.50	2.00	.90	3.00	.90	.90	MIN, SIO2
	9.80	12.90	10.10	7.50	12.90	8.80	9.40	8.00	9.40	12.90	MAX, SIO2
	2.01	2.56	2.41	1.23	2.09	1.86	2.19	2.50	2.24	2.16	SDV, SIO2
413015	0	6	7	31	44	62	113	11	186	230	COUNT, SIO2
	.	6.25	3.77	6.66	6.15	3.49	2.35	1.93	2.70	3.36	MEAN, SIO2
	.	4.50	1.80	3.80	1.80	1.20	.30	.90	.30	.30	MIN, SIO2
	.	10.20	6.70	10.40	10.40	8.80	11.10	4.00	11.10	11.10	MAX, SIO2
	.	2.12	2.05	1.91	2.18	1.02	1.86	.98	1.88	2.37	SDV, SIO2
413016	0	25	7	0	32	39	87	0	126	158	COUNT, SIO2
	.	12.60	10.30	.	12.09	7.46	7.92	.	7.78	8.65	MEAN, SIO2
	.	7.20	9.40	.	7.20	1.40	2.30	.	1.40	1.40	MIN, SIO2
	.	22.60	10.90	.	22.60	11.50	13.70	.	13.70	22.60	MAX, SIO2
	.	5.27	.59	.	4.75	1.96	2.11	.	2.07	3.30	SDV, SIO2
413025	0	0	2	2	4	7	30	7	44	48	COUNT, SIO2
	.	.	.95	5.35	3.15	6.99	4.40	5.11	4.92	4.77	MEAN, SIO2
	.	.	.80	4.80	.80	4.80	.50	4.10	.50	.50	MIN, SIO2
	.	.	1.10	5.90	5.90	7.70	9.70	7.80	9.70	9.70	MAX, SIO2
	.	.	.21	.78	2.58	1.02	2.13	1.29	2.08	2.15	SDV, SIO2
463001	4	3	0	0	7	0	35	6	41	48	COUNT, SIO2
	8.95	11.83	.	.	10.19	.	9.58	10.12	9.66	9.74	MEAN, SIO2
	8.00	11.70	.	.	8.00	.	4.90	9.10	4.90	4.90	MIN, SIO2
	10.30	12.10	.	.	12.10	.	13.70	11.90	13.70	13.70	MAX, SIO2
	.99	.23	.	.	1.70	.	2.44	1.04	2.29	2.20	SDV, SIO2
683089	9	31	0	0	40	24	84	5	113	153	COUNT, SIO2
	4.88	2.49	.	.	3.03	2.68	1.76	.84	1.91	2.20	MEAN, SIO2
	1.40	.28	.	.	.28	1.00	.10	.50	.10	.10	MIN, SIO2
	15.90	13.70	.	.	15.90	6.80	28.90	1.20	28.90	28.90	MAX, SIO2
	5.92	3.41	.	.	4.14	1.52	3.34	.27	2.99	3.35	SDV, SIO2
683090	0	0	0	0	0	15	21	6	42	42	COUNT, SIO2
	.	.	.	.	.	7.95	4.37	4.78	5.71	5.71	MEAN, SIO2
	.	.	.	.	.	6.40	2.00	3.50	2.00	2.00	MIN, SIO2
	.	.	.	.	.	10.00	8.10	5.50	10.00	10.00	MAX, SIO2
	.	.	.	.	.	1.00	1.78	.71	2.18	2.18	SDV, SIO2
TOTAL	28	100	25	60	213	239	612	47	898	1111	COUNT, SIO2
	5.95	6.39	5.52	5.80	6.06	4.95	3.80	4.97	4.23	4.58	MEAN, SIO2
	1.40	.28	.80	3.30	.28	1.00	.10	.01	.01	.01	MIN, SIO2
	15.90	22.60	10.90	10.40	22.60	11.50	28.90	11.90	28.90	28.90	MAX, SIO2
	3.71	5.37	3.61	1.83	4.21	2.42	3.19	3.43	3.06	3.38	SDV, SIO2

Table II-A-18. Seasonal averages and ranges of concentrations of nickel at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	3	2	0	0	5	6	0	0	6	11	COUNT, NI
	.010	.017	-	-	.013	.024	-	-	.024	.019	MEAN, NI
	.010	.010	-	-	.010	.010	-	-	.010	.010	MIN, NI
	.010	.024	-	-	.024	.092	-	-	.092	.092	MAX, NI
	.000	.010	-	-	.006	.033	-	-	.033	.025	SDV, NI
413011	4	0	0	0	4	54	8	0	62	66	COUNT, NI
	.010	-	-	-	.010	.013	.017	-	.013	.013	MEAN, NI
	.010	-	-	-	.010	.010	.010	-	.010	.010	MIN, NI
	.010	-	-	-	.010	.046	.030	-	.046	.046	MAX, NI
	.000	-	-	-	.000	.008	.008	-	.008	.008	SDV, NI
413034	0	0	0	0	0	10	52	7	69	69	COUNT, NI
	-	-	-	-	-	.016	.008	.012	.010	.010	MEAN, NI
	-	-	-	-	-	.010	.001	.005	.001	.001	MIN, NI
	-	-	-	-	-	.036	.034	.028	.036	.036	MAX, NI
	-	-	-	-	-	.010	.007	.009	.008	.008	SDV, NI
413614	9	33	9	27	78	22	56	3	81	159	COUNT, NI
	.010	.083	.008	.007	.039	.010	.010	.005	.010	.024	MEAN, NI
	.010	.005	.004	.000	.000	.002	.002	.004	.002	.000	MIN, NI
	.010	.350	.014	.020	.350	.040	.054	.005	.054	.350	MAX, NI
	.000	.096	.004	.007	.073	.010	.009	.001	.009	.053	SDV, NI
413615	0	6	7	31	44	62	113	11	186	230	COUNT, NI
	-	.016	.026	.017	.018	.032	.017	.021	.022	.022	MEAN, NI
	-	.011	.012	.003	.003	.001	.002	.007	.001	.001	MIN, NI
	-	.021	.039	.060	.060	.143	.079	.050	.143	.143	MAX, NI
	-	.003	.010	.016	.014	.029	.016	.012	.022	.021	SDV, NI
413616	0	25	7	0	32	39	87	0	126	158	COUNT, NI
	-	.069	.019	-	.058	.035	.047	-	.043	.046	MEAN, NI
	-	.027	.010	-	.010	.002	.000	-	.000	.000	MIN, NI
	-	.170	.043	-	.170	.300	.310	-	.310	.310	MAX, NI
	-	.040	.011	-	.061	.059	.061	-	.060	.057	SDV, NI
413625	0	3	2	2	7	7	30	7	44	51	COUNT, NI
	-	.012	.027	.022	.019	.007	.016	.002	.012	.013	MEAN, NI
	-	.009	.015	.022	.009	.001	.001	.001	.001	.001	MIN, NI
	-	.017	.040	.023	.040	.014	.065	.003	.065	.065	MAX, NI
	-	.004	.018	.001	.011	.005	.016	.001	.015	.014	SDV, NI
463001	4	3	0	0	7	0	3	0	3	10	COUNT, NI
	.010	.010	-	-	.010	-	.010	-	.010	.010	MEAN, NI
	.010	.010	-	-	.010	-	.010	-	.010	.010	MIN, NI
	.010	.010	-	-	.010	-	.010	-	.010	.010	MAX, NI
	.000	.000	-	-	.000	-	.000	-	.000	.000	SDV, NI
683089	9	31	0	0	40	24	84	5	113	153	COUNT, NI
	.010	.040	-	-	.033	.026	.011	.003	.014	.019	MEAN, NI
	.010	.007	-	-	.007	.003	.001	.002	.001	.001	MIN, NI
	.010	.290	-	-	.290	.085	.036	.004	.085	.290	MAX, NI
	.000	.059	-	-	.053	.025	.008	.001	.015	.031	SDV, NI
683090	0	0	0	0	0	15	22	6	43	43	COUNT, NI
	-	-	-	-	-	.013	.003	.003	.006	.006	MEAN, NI
	-	-	-	-	-	.006	.001	.002	.001	.001	MIN, NI
	-	-	-	-	-	.019	.006	.004	.019	.019	MAX, NI
	-	-	-	-	-	.004	.001	.001	.006	.006	SDV, NI
TOTAL	29	103	25	60	217	239	455	39	733	950	COUNT, NI
	.010	.057	.018	.013	.034	.023	.019	.010	.020	.023	MEAN, NI
	.010	.005	.004	.000	.000	.001	.000	.001	.000	.000	MIN, NI
	.010	.350	.043	.060	.350	.300	.310	.050	.310	.350	MAX, NI
	.000	.070	.012	.013	.054	.031	.032	.011	.031	.038	SDV, NI

Table II-A-19. Seasonal averages and ranges of concentrations of manganese at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	3	2	0	0	5	6	61	2	69	74	COUNT, MN
	.10	.72	-	-	.35	.40	.23	.18	.24	.25	MEAN, MN
	.08	.67	-	-	.08	.10	.00	.11	.00	.00	MIN, MN
	.11	.78	-	-	.78	.90	.92	.25	.92	.92	MAX, MN
	.02	.08	-	-	.34	.30	.23	.10	.24	.24	SDV, MN
413011	4	0	0	0	4	54	98	0	152	156	COUNT, MN
	.19	-	-	-	.19	.15	.13	-	.14	.14	MEAN, MN
	.11	-	-	-	.11	.06	.00	-	.00	.00	MIN, MN
	.38	-	-	-	.38	.35	1.56	-	1.56	1.56	MAX, MN
	.13	-	-	-	.13	.06	.22	-	.18	.18	SDV, MN
413034	0	0	0	0	0	10	52	7	69	69	COUNT, MN
	-	-	-	-	-	.75	.15	1.29	.35	.35	MEAN, MN
	-	-	-	-	-	.36	.02	.24	.02	.02	MIN, MN
	-	-	-	-	-	1.60	.65	6.60	6.60	6.60	MAX, MN
	-	-	-	-	-	.36	.13	2.35	.81	.81	SDV, MN
413614	9	33	9	27	78	22	56	3	81	159	COUNT, MN
	.14	.53	.18	.11	.30	.14	.11	.11	.12	.21	MEAN, MN
	.06	.03	.06	.05	.03	.02	.00	.08	.00	.00	MIN, MN
	.41	2.30	.25	.24	2.30	.90	1.96	.15	1.96	2.30	MAX, MN
	.11	.56	.06	.07	.42	.21	.26	.04	.24	.35	SDV, MN
413615	0	6	7	31	44	62	113	11	186	230	COUNT, MN
	-	.11	.34	.29	.27	.11	.23	.22	.26	.26	MEAN, MN
	-	.08	.12	.10	.08	.01	.01	.06	.01	.01	MIN, MN
	-	.16	.74	.71	.74	1.08	.91	.60	1.08	1.08	MAX, MN
	-	.03	.23	.20	.20	.27	.18	.20	.22	.21	SDV, MN
413616	0	25	7	0	32	39	87	0	126	158	COUNT, MN
	-	1.07	2.07	-	1.28	.74	1.67	-	1.39	1.36	MEAN, MN
	-	.25	1.26	-	.25	.11	.11	-	.11	.11	MIN, MN
	-	2.90	2.99	-	2.99	4.42	16.23	-	16.23	16.23	MAX, MN
	-	.65	.65	-	.75	1.06	2.65	-	2.32	2.09	SDV, MN
413625	0	3	2	2	7	7	30	7	44	51	COUNT, MN
	-	.45	.27	.66	.46	.10	.34	.10	.26	.29	MEAN, MN
	-	.20	.11	.35	.11	.07	.02	.06	.02	.02	MIN, MN
	-	.63	.43	.98	.98	.15	2.06	.13	2.06	2.06	MAX, MN
	-	.22	.23	.45	.29	.03	.45	.02	.39	.38	SDV, MN
463001	4	3	0	0	7	0	43	9	52	59	COUNT, MN
	.12	.16	-	-	.14	-	.51	.10	.43	.40	MEAN, MN
	.10	.12	-	-	.10	-	.00	.00	.00	.00	MIN, MN
	.14	.19	-	-	.19	-	5.15	.21	5.15	5.15	MAX, MN
	.02	.04	-	-	.03	-	.95	.08	.88	.83	SDV, MN
683089	9	31	0	0	40	24	84	5	113	153	COUNT, MN
	.06	.14	-	-	.12	.22	.10	.03	.12	.12	MEAN, MN
	.02	.02	-	-	.02	.00	.00	.02	.00	.00	MIN, MN
	.14	1.60	-	-	1.60	.90	.53	.06	.90	1.60	MAX, MN
	.04	.28	-	-	.25	.28	.10	.02	.16	.19	SDV, MN
683090	0	0	0	0	0	15	22	6	43	43	COUNT, MN
	-	-	-	-	-	.03	.04	.03	.03	.03	MEAN, MN
	-	-	-	-	-	.00	.00	.02	.00	.00	MIN, MN
	-	-	-	-	-	.07	.11	.04	.11	.11	MAX, MN
	-	-	-	-	-	.02	.03	.01	.02	.02	SDV, MN
TOTAL	29	103	25	60	217	239	646	50	935	1152	COUNT, MN
	.11	.51	.75	.22	.41	.32	.39	.28	.37	.37	MEAN, MN
	.02	.02	.06	.05	.02	.00	.00	.00	.00	.00	MIN, MN
	.41	2.90	2.99	.98	2.99	4.42	16.23	6.60	16.23	16.23	MAX, MN
	.09	.59	.49	.20	.55	.52	1.14	.93	1.01	.94	SDV, MN

Table II-A-20. Seasonal averages and ranges of concentrations of chromium at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	6	61	2	69	78	COUNT, CR
	.004	.040	.	.	.012	.044	.035	.006	.035	.032	MEAN, CR
	.001	.030	.	.	.001	.001	.001	.003	.001	.001	MIN, CR
	.006	.051	.	.	.051	.083	.543	.009	.543	.543	MAX, CR
	.001	.015	.	.	.017	.027	.081	.004	.077	.073	SDV, CR
413011	7	0	0	0	7	54	98	0	152	159	COUNT, CR
	.004	.	.	.	.004	.009	.014	.	.012	.012	MEAN, CR
	.001	.	.	.	.001	.001	.001	.	.001	.001	MIN, CR
	.015	.	.	.	.015	.096	.132	.	.132	.132	MAX, CR
	.005	.	.	.	.005	.015	.017	.	.016	.016	SDV, CR
413034	0	0	0	0	0	10	52	7	69	69	COUNT, CR
	.	.	.	.	.	.048	.013	.062	.023	.023	MEAN, CR
	.	.	.	.	.	.014	.002	.031	.002	.002	MIN, CR
	.	.	.	.	.	.072	.094	.120	.120	.120	MAX, CR
	.	.	.	.	.	.017	.014	.040	.025	.025	SDV, CR
413614	9	33	9	27	78	22	56	3	81	159	COUNT, CR
	.002	.031	.018	.016	.021	.008	.010	.011	.010	.015	MEAN, CR
	.001	.001	.013	.009	.001	.001	.000	.010	.000	.000	MIN, CR
	.005	.170	.024	.026	.170	.029	.044	.012	.044	.170	MAX, CR
	.001	.044	.003	.006	.030	.006	.009	.001	.008	.023	SDV, CR
413615	0	6	7	31	44	62	113	11	186	230	COUNT, CR
	.	.013	.027	.050	.042	.032	.027	.076	.032	.034	MEAN, CR
	.	.010	.017	.012	.010	.000	.006	.006	.000	.000	MIN, CR
	.	.015	.037	.127	.127	.103	.130	.298	.298	.298	MAX, CR
	.	.002	.008	.033	.031	.025	.020	.090	.032	.032	SDV, CR
413616	0	25	7	0	32	39	87	0	126	158	COUNT, CR
	.	.220	.053	.	.184	.034	.069	.	.058	.081	MEAN, CR
	.	.010	.040	.	.010	.001	.002	.	.001	.001	MIN, CR
	.	1.700	.072	.	1.700	.203	.307	.	.307	1.700	MAX, CR
	.	.359	.012	.	.324	.042	.067	.	.062	.162	SDV, CR
413625	0	3	2	2	7	7	30	7	44	51	COUNT, CR
	.	.007	.026	.037	.021	.007	.013	.002	.011	.012	MEAN, CR
	.	.007	.026	.033	.007	.005	.001	.000	.000	.000	MIN, CR
	.	.007	.027	.041	.041	.009	.072	.006	.072	.072	MAX, CR
	.	.000	.001	.006	.014	.001	.016	.002	.014	.014	SDV, CR
463001	9	3	0	0	12	0	43	9	52	64	COUNT, CR
	.003	.001	.	.	.002	.	.024	.004	.021	.017	MEAN, CR
	.001	.001	.	.	.001	.	.001	.001	.001	.001	MIN, CR
	.008	.001	.	.	.008	.	.229	.006	.229	.229	MAX, CR
	.003	.000	.	.	.002	.	.043	.002	.040	.037	SDV, CR
683089	9	31	0	0	40	24	84	5	113	153	COUNT, CR
	.208	.040	.	.	.078	.021	.018	.002	.018	.033	MEAN, CR
	.006	.003	.	.	.003	.003	.002	.000	.000	.000	MIN, CR
	.930	.300	.	.	.930	.097	.087	.005	.097	.930	MAX, CR
	.377	.060	.	.	.192	.023	.014	.002	.016	.102	SDV, CR
683090	0	0	0	0	0	15	22	6	43	43	COUNT, CR
	.	.	.	.	.	.006	.004	.002	.004	.004	MEAN, CR
	.	.	.	.	.	.002	.001	.001	.001	.001	MIN, CR
	.	.	.	.	.	.014	.017	.003	.017	.017	MAX, CR
	.	.	.	.	.	.003	.004	.001	.004	.004	SDV, CR
TOTAL	41	103	25	60	229	239	646	50	935	1164	COUNT, CR
	.048	.077	.031	.034	.056	.022	.026	.028	.025	.031	MEAN, CR
	.001	.001	.013	.009	.001	.000	.000	.000	.000	.000	MIN, CR
	.930	1.700	.072	.127	1.700	.203	.543	.298	.543	1.700	MAX, CR
	.189	.197	.016	.029	.156	.027	.043	.055	.040	.079	SDV, CR

Table II-A-21. Seasonal averages and ranges of concentrations of lead at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	6	61	2	69	78	COUNT, PB
	.08	.59	.	.	.20	1.25	.31	.21	.39	.37	MEAN, PB
	.03	.53	.	.	.03	.18	.08	.19	.08	.03	MIN, PB
	.16	.65	.	.	.65	2.90	.84	.24	2.90	2.90	MAX, PB
	.04	.08	.	.	.23	1.04	.20	.04	.43	.42	SDV, PB
413011	7	0	0	0	7	54	98	0	152	159	COUNT, PB
	.04	.	.	.	.04	.06	.11	.	.09	.09	MEAN, PB
	.01	.	.	.	.01	.01	.00	.	.00	.00	MIN, PB
	.07	.	.	.	.07	.24	.76	.	.76	.76	MAX, PB
	.02	.	.	.	.02	.05	.11	.	.09	.09	SDV, PB
413034	0	0	0	0	0	10	52	7	69	69	COUNT, PB
	.	.	.	.	.	1.46	.23	1.30	.52	.52	MEAN, PB
	.	.	.	.	.	.70	.07	.58	.07	.07	MIN, PB
	.	.	.	.	.	2.70	.61	2.53	2.70	2.70	MAX, PB
	.	.	.	.	.	.57	.14	.86	.62	.62	SDV, PB
413014	9	33	9	27	78	22	56	3	81	159	COUNT, PB
	.07	.51	.21	.34	.36	.22	.17	.15	.18	.27	MEAN, PB
	.00	.00	.02	.01	.00	.01	.00	.12	.00	.00	MIN, PB
	.21	2.80	.36	1.26	2.80	1.28	2.33	.18	2.33	2.80	MAX, PB
	.06	.84	.14	.42	.61	.32	.32	.03	.32	.49	SDV, PB
413015	0	6	7	31	44	61	113	11	185	229	COUNT, PB
	.	.29	1.23	2.28	1.84	2.23	1.28	1.72	1.62	1.66	MEAN, PB
	.	.14	.01	.16	.01	.20	.13	.24	.13	.01	MIN, PB
	.	.35	2.48	7.99	7.99	9.02	7.46	6.22	9.02	9.02	MAX, PB
	.	.09	.82	2.00	2.31	2.15	1.23	2.14	1.70	1.63	SDV, PB
413016	0	25	7	0	32	39	87	0	126	158	COUNT, PB
	.	1.73	.93	.	1.56	.61	1.60	.	1.29	1.34	MEAN, PB
	.	.07	.66	.	.07	.01	.03	.	.01	.01	MIN, PB
	.	8.60	1.70	.	8.60	3.02	18.04	.	18.04	18.04	MAX, PB
	.	1.87	.44	.	1.69	.96	2.81	.	2.43	2.30	SDV, PB
413029	0	3	2	2	7	7	30	7	44	51	COUNT, PB
	.	.23	.06	1.00	.40	.08	.19	.09	.16	.19	MEAN, PB
	.	.18	.05	.52	.05	.01	.01	.07	.01	.01	MIN, PB
	.	.28	.08	1.49	1.49	.17	.60	.12	.60	1.49	MAX, PB
	.	.05	.01	.69	.51	.06	.16	.02	.14	.23	SDV, PB
463001	9	3	0	0	12	0	43	9	52	64	COUNT, PB
	.00	.00	.	.	.00	.	.07	.07	.07	.06	MEAN, PB
	.00	.00	.	.	.00	.	.00	.03	.00	.00	MIN, PB
	.01	.00	.	.	.01	.	.26	.11	.26	.26	MAX, PB
	.00	.00	.	.	.00	.	.05	.02	.05	.05	SDV, PB
683089	9	31	0	0	40	24	84	5	113	153	COUNT, PB
	.22	.48	.	.	.42	.77	.38	.11	.45	.44	MEAN, PB
	.01	.02	.	.	.01	.02	.03	.08	.02	.01	MIN, PB
	.38	1.80	.	.	1.80	2.93	1.30	.17	2.93	2.93	MAX, PB
	.14	.52	.	.	.47	.87	.31	.04	.51	.50	SDV, PB
683090	0	0	0	0	0	15	22	6	43	43	COUNT, PB
	.	.	.	.	.	.03	.08	.06	.06	.06	MEAN, PB
	.	.	.	.	.	.00	.04	.06	.00	.00	MIN, PB
	.	.	.	.	.	.06	.12	.07	.12	.12	MAX, PB
	.	.	.	.	.	.02	.02	.00	.03	.03	SDV, PB
TOTAL	41	103	25	60	229	238	646	50	934	1163	COUNT, PB
	.08	.76	.68	1.36	.79	.86	.58	.62	.66	.69	MEAN, PB
	.00	.00	.01	.01	.00	.00	.00	.03	.00	.00	MIN, PB
	.38	8.60	2.48	7.99	8.60	9.02	18.04	6.22	18.04	18.04	MAX, PB
	.10	1.30	.66	2.11	1.42	1.48	1.29	1.24	1.35	1.36	SDV, PB

Table II-A-22. Seasonal averages and ranges of concentrations of zinc at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	6	61	2	69	78	COUNT, ZN
	.12	.51	-	-	.20	.68	.23	.15	.27	.26	MEAN, ZN
	.03	.47	-	-	.03	.09	.01	.12	.01	.01	MIN, ZN
	.24	.55	-	-	.55	1.10	.84	.19	1.10	1.10	MAX, ZN
	.07	.06	-	-	.18	.35	.15	.05	.21	.21	SDV, ZN
413011	7	0	0	0	7	54	98	0	152	159	COUNT, ZN
	.08	-	-	-	.08	.14	.10	-	.12	.11	MEAN, ZN
	.03	-	-	-	.03	.06	.01	-	.01	.01	MIN, ZN
	.12	-	-	-	.12	.39	.49	-	.49	.49	MAX, ZN
	.04	-	-	-	.04	.07	.11	-	.10	.10	SDV, ZN
413034	0	0	0	0	0	10	52	7	69	69	COUNT, ZN
	-	-	-	-	-	.43	.18	.58	.26	.26	MEAN, ZN
	-	-	-	-	-	.08	.03	.32	.03	.03	MIN, ZN
	-	-	-	-	-	1.10	.92	1.02	1.10	1.10	MAX, ZN
	-	-	-	-	-	.23	.15	.30	.31	.31	SDV, ZN
413614	9	33	9	27	78	22	56	3	81	159	COUNT, ZN
	.26	.64	.44	.36	.47	.42	.31	.33	.34	.41	MEAN, ZN
	.10	.05	.07	.14	.05	.08	.01	.19	.01	.01	MIN, ZN
	.43	2.50	1.10	.97	2.50	1.58	2.24	.47	2.24	2.50	MAX, ZN
	.11	.67	.29	.29	.49	.41	.26	.14	.33	.42	SDV, ZN
413615	0	6	7	31	44	62	113	11	186	230	COUNT, ZN
	-	.30	1.04	.79	.76	1.33	.59	.63	.74	.74	MEAN, ZN
	-	.25	.38	.24	.20	.20	.09	.11	.09	.09	MIN, ZN
	-	.36	1.71	1.97	1.97	5.32	2.32	2.03	5.32	5.32	MAX, ZN
	-	.04	.51	.57	.56	.74	.42	.45	.60	.59	SDV, ZN
413616	0	25	7	0	32	39	87	0	126	158	COUNT, ZN
	-	2.31	1.94	-	2.23	1.48	2.87	-	2.44	2.40	MEAN, ZN
	-	.98	1.19	-	.98	.19	.31	-	.19	.19	MIN, ZN
	-	5.50	3.25	-	5.50	8.03	13.00	-	13.00	13.00	MAX, ZN
	-	1.10	.75	-	1.10	2.23	2.71	-	2.64	2.41	SDV, ZN
413625	0	3	2	2	7	7	30	7	44	51	COUNT, ZN
	-	.50	.08	2.15	.85	.15	.11	.01	.10	.21	MEAN, ZN
	-	.06	.07	.70	.06	.08	.01	.00	.00	.00	MIN, ZN
	-	.79	.09	3.60	3.60	.30	.49	.02	.49	3.60	MAX, ZN
	-	.39	.01	2.05	1.25	.08	.13	.01	.12	.52	SDV, ZN
463001	9	3	0	0	12	0	43	9	52	64	COUNT, ZN
	.03	.02	-	-	.03	-	.15	.01	.13	.11	MEAN, ZN
	.01	.01	-	-	.01	-	.00	.00	.00	.00	MIN, ZN
	.06	.03	-	-	.06	-	2.13	.03	2.13	2.13	MAX, ZN
	.03	.01	-	-	.02	-	.35	.01	.32	.29	SDV, ZN
683089	9	31	0	0	40	24	84	5	113	153	COUNT, ZN
	.16	.24	-	-	.22	.46	.19	.02	.26	.25	MEAN, ZN
	.10	.10	-	-	.10	.12	.01	.01	.01	.01	MIN, ZN
	.23	.77	-	-	.77	1.13	1.05	.06	1.13	1.13	MAX, ZN
	.04	.18	-	-	.16	.30	.19	.01	.24	.22	SDV, ZN
683090	0	0	0	0	0	15	22	6	43	43	COUNT, ZN
	-	-	-	-	-	.28	.06	.03	.13	.13	MEAN, ZN
	-	-	-	-	-	.07	.03	.01	.01	.01	MIN, ZN
	-	-	-	-	-	.75	.10	.04	.75	.75	MAX, ZN
	-	-	-	-	-	.21	.02	.01	.17	.17	SDV, ZN
TOTAL	41	103	25	60	229	239	646	50	935	1164	COUNT, ZN
	.13	.88	1.00	.66	.70	.70	.61	.26	.61	.63	MEAN, ZN
	.01	.01	.07	.14	.01	.06	.00	.00	.00	.00	MIN, ZN
	.43	5.50	3.25	3.60	5.50	8.03	13.00	2.03	13.00	13.00	MAX, ZN
	.10	1.04	.83	.63	.84	1.10	1.36	.42	1.27	1.20	SDV, ZN

Table II-A-23. Seasonal averages and ranges of concentrations of copper at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	6	61	2	69	78	COUNT, CU
	.02	.13	.	.	.04	1.00	.11	.18	.19	.17	MEAN, CU
	.01	.11	.	.	.01	.00	.00	.07	.00	.00	MIN, CU
	.04	.15	.	.	.15	3.00	.30	.29	3.00	3.00	MAX, CU
	.01	.03	.	.	.05	1.32	.06	.16	.40	.42	SDV, CU
413011	7	0	0	0	7	54	98	0	152	159	COUNT, CU
	.01	.	.	.	.01	.13	.07	.	.09	.09	MEAN, CU
	.00	.	.	.	.00	.00	.03	.	.00	.00	MIN, CU
	.02	.	.	.	.02	.15	.10	.	.15	.15	MAX, CU
	.01	.	.	.	.01	.03	.04	.	.04	.04	SDV, CU
413034	0	0	0	0	0	10	52	7	69	69	COUNT, CU
	.	.	.	.	.	.30	.06	.10	.10	.10	MEAN, CU
	.	.	.	.	.	.06	.03	.05	.03	.03	MIN, CU
	.	.	.	.	.	1.33	.16	.18	1.33	1.33	MAX, CU
	.	.	.	.	.	.38	.02	.05	.16	.16	SDV, CU
413614	9	33	9	27	78	22	56	3	81	159	COUNT, CU
	.01	.06	.03	.06	.05	.05	.04	.04	.04	.04	MEAN, CU
	.00	.01	.01	.01	.00	.01	.01	.03	.01	.00	MIN, CU
	.02	.22	.06	.10	.22	.10	.22	.05	.22	.22	MAX, CU
	.00	.07	.02	.02	.05	.02	.03	.01	.03	.04	SDV, CU
413615	0	6	7	31	44	62	113	11	186	230	COUNT, CU
	.	.07	.13	.17	.15	.19	.13	.21	.16	.16	MEAN, CU
	.	.05	.08	.06	.05	.01	.06	.08	.01	.01	MIN, CU
	.	.08	.19	.68	.68	.50	.60	.52	.60	.68	MAX, CU
	.	.01	.00	.12	.11	.13	.10	.21	.12	.12	SDV, CU
413616	0	25	7	0	32	39	87	0	126	158	COUNT, CU
	.	.16	.16	.	.16	.16	.30	.	.25	.23	MEAN, CU
	.	.01	.11	.	.01	.05	.04	.	.04	.01	MIN, CU
	.	.43	.20	.	.43	.66	2.76	.	2.76	2.76	MAX, CU
	.	.16	.05	.	.17	.13	.42	.	.36	.33	SDV, CU
413625	0	3	2	2	7	7	30	7	44	51	COUNT, CU
	.	.06	.02	.11	.07	.04	.06	.02	.06	.06	MEAN, CU
	.	.04	.02	.09	.02	.03	.01	.01	.01	.01	MIN, CU
	.	.10	.03	.13	.13	.07	.11	.02	.11	.13	MAX, CU
	.	.03	.00	.03	.04	.01	.02	.01	.02	.03	SDV, CU
663001	9	3	0	0	12	0	43	9	52	64	COUNT, CU
	.02	.02	.	.	.02	.	.06	.04	.06	.05	MEAN, CU
	.00	.01	.	.	.00	.	.02	.01	.01	.00	MIN, CU
	.10	.02	.	.	.10	.	.22	.09	.22	.22	MAX, CU
	.03	.00	.	.	.03	.	.04	.03	.04	.04	SDV, CU
683089	9	31	0	0	40	24	80	9	113	153	COUNT, CU
	.02	.03	.	.	.02	.13	.05	.01	.06	.05	MEAN, CU
	.01	.00	.	.	.00	.03	.01	.01	.01	.00	MIN, CU
	.02	.07	.	.	.07	1.02	.10	.02	1.02	1.02	MAX, CU
	.01	.02	.	.	.02	.21	.03	.01	.11	.09	SDV, CU
683090	0	0	0	0	0	15	22	8	45	45	COUNT, CU
	.	.	.	.	.	.03	.06	.01	.03	.03	MEAN, CU
	.	.	.	.	.	.02	.02	.01	.01	.01	MIN, CU
	.	.	.	.	.	.05	.15	.02	.15	.15	MAX, CU
	.	.	.	.	.	.01	.03	.00	.02	.02	SDV, CU
TOTAL	41	103	25	60	229	239	642	56	937	1166	COUNT, CU
	.02	.07	.08	.12	.06	.10	.11	.08	.11	.11	MEAN, CU
	.00	.00	.01	.01	.00	.00	.00	.01	.00	.00	MIN, CU
	.10	.43	.20	.68	.68	3.00	2.76	.52	3.00	3.00	MAX, CU
	.02	.09	.07	.11	.08	.28	.18	.13	.21	.19	SDV, CU

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Table II-A-24. Seasonal averages and ranges of concentrations of cadmium at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	7	2	0	0	9	8	41	2	50	59	COUNT, CD
	.001	.008	.	.	.003	.102	.003	.001	.012	.011	MEAN, CD
	.000	.007	.	.	.000	.000	.000	.001	.000	.000	MIN, CD
	.004	.008	.	.	.008	.550	.010	.002	.550	.550	MAX, CD
	.001	.001	.	.	.003	.220	.004	.001	.094	.092	SDV, CD
413011	7	0	0	0	7	54	88	0	142	149	COUNT, CD
	.000	.	.	.	.000	.001	.001	.	.001	.001	MEAN, CD
	.000	.	.	.	.000	.000	.000	.	.000	.000	MIN, CD
	.001	.	.	.	.001	.012	.004	.	.012	.012	MAX, CD
	.000	.	.	.	.000	.002	.001	.	.001	.001	SDV, CD
413034	0	0	0	0	0	10	32	6	48	48	COUNT, CD
	.	.	.	.	.	.014	.003	.006	.005	.005	MEAN, CD
	.	.	.	.	.	.004	.000	.004	.000	.000	MIN, CD
	.	.	.	.	.	.026	.011	.012	.026	.026	MAX, CD
	.	.	.	.	.	.008	.002	.003	.005	.005	SDV, CD
413014	4	33	6	27	70	22	55	3	80	150	COUNT, CD
	.001	.008	.004	.005	.006	.008	.005	.010	.006	.006	MEAN, CD
	.000	.000	.002	.000	.000	.002	.001	.003	.001	.000	MIN, CD
	.002	.055	.008	.014	.055	.021	.025	.016	.025	.055	MAX, CD
	.001	.012	.001	.005	.006	.006	.006	.007	.005	.007	SDV, CD
413015	0	6	7	31	44	42	113	11	166	210	COUNT, CD
	.	.013	.006	.006	.007	.010	.006	.007	.007	.007	MEAN, CD
	.	.002	.004	.003	.002	.000	.001	.003	.000	.000	MIN, CD
	.	.023	.008	.014	.023	.051	.022	.017	.051	.051	MAX, CD
	.	.008	.001	.005	.005	.008	.004	.004	.006	.006	SDV, CD
413016	0	25	7	0	32	39	86	0	125	157	COUNT, CD
	.	.026	.017	.	.024	.012	.021	.	.018	.019	MEAN, CD
	.	.004	.010	.	.004	.003	.003	.	.003	.003	MIN, CD
	.	.064	.036	.	.064	.041	.070	.	.070	.070	MAX, CD
	.	.017	.009	.	.016	.011	.019	.	.016	.015	SDV, CD
413025	0	3	1	2	6	7	30	7	44	50	COUNT, CD
	.	.005	.013	.015	.010	.011	.013	.003	.006	.009	MEAN, CD
	.	.000	.013	.004	.000	.003	.000	.000	.000	.000	MIN, CD
	.	.011	.013	.026	.026	.021	.031	.012	.031	.031	MAX, CD
	.	.005	.	.016	.009	.007	.005	.001	.006	.008	SDV, CD
443001	9	3	0	0	12	0	43	9	52	64	COUNT, CD
	.001	.002	.	.	.001	.	.002	.000	.002	.002	MEAN, CD
	.000	.001	.	.	.000	.	.000	.000	.000	.000	MIN, CD
	.002	.003	.	.	.003	.	.019	.000	.019	.019	MAX, CD
	.001	.001	.	.	.001	.	.003	.000	.003	.003	SDV, CD
483008	9	31	0	0	40	20	84	9	113	153	COUNT, CD
	.001	.008	.	.	.006	.011	.005	.003	.006	.006	MEAN, CD
	.000	.001	.	.	.000	.003	.000	.002	.000	.000	MIN, CD
	.003	.036	.	.	.036	.041	.029	.004	.041	.041	MAX, CD
	.001	.006	.	.	.006	.009	.004	.001	.006	.006	SDV, CD
483090	0	0	0	0	0	15	22	6	43	43	COUNT, CD
	.	.	.	.	.	.006	.005	.002	.004	.004	MEAN, CD
	.	.	.	.	.	.001	.001	.001	.001	.001	MIN, CD
	.	.	.	.	.	.017	.015	.003	.017	.017	MAX, CD
	.	.	.	.	.	.004	.004	.001	.004	.004	SDV, CD
TOTAL	41	113	26	60	240	230	545	48	823	1063	COUNT, CD
	.001	.012	.010	.006	.008	.010	.006	.006	.007	.007	MEAN, CD
	.000	.000	.002	.000	.000	.000	.000	.000	.000	.000	MIN, CD
	.004	.064	.036	.026	.064	.550	.070	.017	.550	.550	MAX, CD
	.001	.014	.008	.005	.011	.036	.009	.004	.020	.018	SDV, CD

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Table II-A-25. Seasonal averages and ranges of concentrations of arsenic at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	FALL 76	WINTER 76-77	ANNUAL 76	SPRING 77	SUMMER 77	FALL 77	ANNUAL 77	TOTAL	
413010	3	2	0	0	5	6	0	0	6	11	COUNT, AS
	.005	.005	-	-	.005	.006	-	-	.006	.005	MEAN, AS
	.005	.005	-	-	.005	.005	-	-	.005	.005	MIN, AS
	.005	.005	-	-	.005	.010	-	-	.010	.010	MAX, AS
	.000	.000	-	-	.000	.002	-	-	.002	.002	SDV, AS
413011	4	0	0	0	4	58	8	0	62	66	COUNT, AS
	.005	-	-	-	.005	.005	.005	-	.005	.005	MEAN, AS
	.005	-	-	-	.005	.005	.005	-	.005	.005	MIN, AS
	.005	-	-	-	.005	.005	.005	-	.005	.005	MAX, AS
	.000	-	-	-	.000	.000	.000	-	.000	.000	SDV, AS
413034	0	0	0	0	0	10	52	7	69	69	COUNT, AS
	-	-	-	-	-	.005	.003	.004	.003	.003	MEAN, AS
	-	-	-	-	-	.005	.000	.001	.000	.000	MIN, AS
	-	-	-	-	-	.005	.011	.008	.011	.011	MAX, AS
	-	-	-	-	-	.000	.002	.003	.002	.002	SDV, AS
413614	9	33	9	27	78	22	56	3	81	159	COUNT, AS
	.005	.017	.002	.006	.010	.004	.005	.003	.005	.008	MEAN, AS
	.005	.004	.000	.003	.000	.002	.000	.003	.000	.000	MIN, AS
	.005	.093	.003	.012	.093	.010	.017	.003	.017	.093	MAX, AS
	.000	.020	.001	.002	.014	.002	.003	.000	.003	.010	SDV, AS
413615	0	6	7	31	44	62	113	11	186	230	COUNT, AS
	-	.012	.004	.007	.007	.007	.005	.002	.006	.006	MEAN, AS
	-	.009	.001	.003	.001	.001	.001	.001	.001	.001	MIN, AS
	-	.016	.008	.013	.016	.032	.015	.004	.032	.032	MAX, AS
	-	.003	.003	.002	.003	.006	.003	.001	.004	.004	SDV, AS
413616	0	25	7	0	32	39	87	0	126	158	COUNT, AS
	-	.022	.009	-	.019	.008	.011	-	.010	.012	MEAN, AS
	-	.013	.004	-	.004	.001	.000	-	.000	.000	MIN, AS
	-	.042	.017	-	.042	.040	.099	-	.099	.099	MAX, AS
	-	.009	.004	-	.010	.008	.015	-	.013	.013	SDV, AS
413625	0	3	2	2	7	7	30	7	44	51	COUNT, AS
	-	.008	.004	.006	.006	.002	.005	.002	.004	.004	MEAN, AS
	-	.006	.001	.003	.001	.000	.000	.001	.000	.000	MIN, AS
	-	.009	.007	.010	.010	.004	.022	.003	.022	.022	MAX, AS
	-	.002	.004	.005	.003	.001	.005	.001	.004	.004	SDV, AS
463001	4	3	0	0	7	0	3	0	3	10	COUNT, AS
	.005	.005	-	-	.005	-	.005	-	.005	.005	MEAN, AS
	.005	.005	-	-	.005	-	.005	-	.005	.005	MIN, AS
	.005	.005	-	-	.005	-	.005	-	.005	.005	MAX, AS
	.000	.000	-	-	.000	-	.000	-	.000	.000	SDV, AS
683089	9	31	0	0	40	24	84	5	113	153	COUNT, AS
	.005	.012	-	-	.010	.009	.005	.003	.006	.007	MEAN, AS
	.005	.003	-	-	.003	.002	.000	.000	.000	.000	MIN, AS
	.005	.104	-	-	.104	.036	.024	.007	.036	.104	MAX, AS
	.000	.023	-	-	.020	.008	.004	.003	.005	.011	SDV, AS
683090	0	0	0	0	0	15	22	6	43	43	COUNT, AS
	-	-	-	-	-	.005	.003	.002	.004	.004	MEAN, AS
	-	-	-	-	-	.003	.001	.001	.001	.001	MIN, AS
	-	-	-	-	-	.008	.004	.003	.008	.008	MAX, AS
	-	-	-	-	-	.002	.001	.001	.002	.002	SDV, AS
TOTAL	29	103	25	60	217	239	455	39	733	950	COUNT, AS
	.005	.016	.004	.007	.010	.006	.006	.003	.006	.007	MEAN, AS
	.005	.003	.000	.003	.000	.000	.000	.000	.000	.000	MIN, AS
	.005	.104	.017	.013	.104	.040	.099	.008	.099	.104	MAX, AS
	.000	.018	.004	.002	.013	.005	.008	.002	.007	.009	SDV, AS

Table II-A-26. Seasonal averages and ranges of concentrations of selenium at the predominantly single land use monitoring sites

	SPRING 76	SUMMER 76	ANNUAL 76	SPRING 77	SUMMER 77	ANNUAL 77	TOTAL	
413010	3	2	5	6	0	6	11	COUNT, SE
	.00	.00	.00	.00	-	.00	.00	MEAN, SE
	.00	.00	.00	.00	-	.00	.00	MIN, SE
	.00	.00	.00	.00	-	.00	.00	MAX, SE
	.00	.00	.00	.00	-	.00	.00	SDV, SE
413011	4	0	4	54	8	62	66	COUNT, SE
	.00	-	.00	.00	.00	.00	.00	MEAN, SE
	.00	-	.00	.00	.00	.00	.00	MIN, SE
	.00	-	.00	.00	.00	.00	.00	MAX, SE
	.00	-	.00	.00	.00	.00	.00	SDV, SE
413034	0	0	0	10	0	10	10	COUNT, SE
	-	-	-	.00	-	.00	.00	MEAN, SE
	-	-	-	.00	-	.00	.00	MIN, SE
	-	-	-	.02	-	.02	.02	MAX, SE
	-	-	-	.01	-	.01	.01	SDV, SE
413614	9	33	42	0	0	0	42	COUNT, SE
	.00	.03	.02	-	-	-	.02	MEAN, SE
	.00	.00	.00	-	-	-	.00	MIN, SE
	.00	.09	.09	-	-	-	.09	MAX, SE
	.00	.03	.03	-	-	-	.03	SDV, SE
413615	0	6	6	0	0	0	6	COUNT, SE
	-	.01	.01	-	-	-	.01	MEAN, SE
	-	.01	.01	-	-	-	.01	MIN, SE
	-	.02	.02	-	-	-	.02	MAX, SE
	-	.00	.00	-	-	-	.00	SDV, SE
413616	0	25	25	0	0	0	25	COUNT, SE
	-	.04	.04	-	-	-	.04	MEAN, SE
	-	.01	.01	-	-	-	.01	MIN, SE
	-	.10	.10	-	-	-	.10	MAX, SE
	-	.04	.04	-	-	-	.04	SDV, SE
463001	4	3	7	0	3	3	10	COUNT, SE
	.00	.00	.00	-	.00	.00	.00	MEAN, SE
	.00	.00	.00	-	.00	.00	.00	MIN, SE
	.00	.01	.01	-	.01	.01	.01	MAX, SE
	.00	.00	.00	-	.00	.00	.00	SDV, SE
683089	9	31	40	0	0	0	40	COUNT, SE
	.00	.00	.00	-	-	-	.00	MEAN, SE
	.00	.00	.00	-	-	-	.00	MIN, SE
	.00	.02	.02	-	-	-	.02	MAX, SE
	.00	.00	.00	-	-	-	.00	SDV, SE
TOTAL	29	100	129	70	11	81	210	COUNT, SE
	.00	.02	.02	.00	.00	.00	.01	MEAN, SE
	.00	.00	.00	.00	.00	.00	.00	MIN, SE
	.00	.10	.10	.02	.01	.02	.10	MAX, SE
	.00	.03	.03	.00	.00	.00	.02	SDV, SE

Table II-A-27. Seasonal average of concentrations of total, suspended, volatile suspended solids; alkalinity; hardness; total and soluble phosphorus; organic, ammonia and nitrate + nitrite nitrogen; total organic carbon and chloride during non-events at the predominantly single land use monitoring sites

STORET number	Spring 75	Summer 75	Fall 75	Winter 75–76	Spring 76	Summer 76	Fall 76	Winter 76–77	Spring 77	Summer 77	Fall 77	Total	
						Total Solids							
463001	8 704.75 62.96	12 683.67 40.36	9 661.33 51.99	9 714.00 41.15	15 599.80 61.31	10 616.40 64.48	7 665.00 36.06	1 810.00 .00				71 659.80 53.26	Count Mean SDV
413011	9 927.11 324.73	16 558.50 244.03	9 731.11 328.38	7 3657.71 1543.52	18 1570.17 936.75	8 792.62 197.69	6 1390.83 1958.76	1 2688.00 .00		10 343.00 47.91		84 1172.99 826.96	Count Mean SDV
						Suspended Solids							
463001	14 6.79 3.14	21 24.14 34.65	10 13.60 22.97	10 14.70 40.87	163 125.79 236.76	20 29.50 17.95	14 43.79 60.56	12 9.00 6.97	17 14.18 29.30	21 43.86 34.83	6 103.67 34.74	308 79.49 176.22	Count Mean SDV
413011	10 13.00 9.63	22 11.77 8.96	11 30.73 53.92	10 45.50 86.31	193 332.99 476.51	32 60.31 124.26	20 21.05 10.20	1 404.00 .00	16 37.62 38.27	36 71.14 75.50	10 78.90 29.10	361 199.88 356.19	Count Mean SDV
						Volatile Suspended Solids							
463001	8 1.37 1.06	12 3.33 2.35	9 4.00 4.33	9 1.22 1.09	15 6.20 3.43	10 8.10 5.09	7 5.57 6.55	1 .00 .00				71 4.38 3.74	Count Mean SDV
413011	9 2.44 1.81	16 4.62 3.28	9 4.56 2.35	7 3.43 1.40	18 6.61 4.64	8 21.00 48.18	6 2.33 1.37	1 44.00 .00		10 15.80 7.36		84 7.90 15.21	Count Mean SDV
							Alkalinity						
463001	8 255.00 21.25	12 280.00 18.03	9 294.56 9.88	9 286.67 15.74	15 220.07 31.65	10 267.30 44.36	7 279.71 27.91	1 250.00 .00				71 264.97 26.99	Count Mean SDV
413011	9 218.00 65.40	16 171.88 48.81	9 224.44 78.32	7 470.43 43.48	17 264.00 73.79	8 200.25 39.40	6 193.67 16.61	1 190.00 .00		2 90.00 14.14		75 235.29 59.02	Count Mean SDV

Table II-A-27 continued

STORET number	Spring 75	Summer 75	Fall 75	Winter 75-76	Spring 76	Summer 76	Fall 76	Winter 76-77	Summer 77	Fall 77	Total	
Hardness												
463001	8	12	9	9	15	10	7	1			71	Count
	466.87	481.67	493.33	539.44	415.40	467.40	500.00	575.00			475.92	Mean
	23.89	15.42	54.08	27.55	57.69	63.93	68.07	.00			48.35	SDV
413011	9	16	9	7	17	8	6	1	2		75	Count
	436.67	286.19	380.00	892.14	517.71	370.37	363.33	350.00	130.50		436.39	Mean
	133.91	116.19	135.95	120.55	151.11	109.14	111.52	.00	37.48		128.71	SDV
Total Phosphorus												
463001	8	12	9	9	15	10	7	1	2	16	79	Count
	.07	.10	.09	.04	.16	.11	.06	.12	.11	.10	.10	Mean
	.05	.02	.08	.01	.16	.03	.04	.00	.02	.04	.08	SDV
413011	9	16	9	7	18	8	6	1	11	10	95	Count
	.08	.10	.06	.09	.09	.19	.05	.64	.14	.09	.11	Mean
	.06	.04	.04	.05	.08	.41	.02	.00	.05	.04	.13	SDV
Soluble Phosphorus												
463001	8	12	9	9	15	10	7	1			71	Count
	.03	.07	.09	.03	.09	.05	.01	.07			.06	Mean
	.02	.03	.13	.00	.12	.02	.00	.00			.07	SDV
413011	9	16	9	7	17	8	6	1	9		82	Count
	.04	.05	.01	.04	.03	.01	.01	.06	.04		.03	Mean
	.04	.04	.01	.05	.05	.00	.00	.00	.01		.04	SDV
Total Organic Nitrogen												
463001	8	12	9	9	15	10	7	1			71	Count
	.99	.65	.70	.71	1.29	.71	.50	1.90			.85	Mean
	.38	.17	.33	.22	.28	.18	.22	.00			.26	SDV
413011	9	16	9	7	18	8	6	1	10		84	Count
	.55	.60	1.05	.74	.64	1.71	.84	2.60	.70		.82	Mean
	.16	.30	.51	.18	.22	2.75	.31	.00	.13		.88	SDV

Table II-A-27 continued

STORET number	Spring 75	Summer 75	Fall 75	Winter 75-76	Spring 76	Summer 76	Fall 76	Winter 76-77	Summer 77	Total	
							NH_3-N				
463001	8	12	9	9	15	10	7	1		71	Count
	.10	.11	.20	.28	.20	.10	.09	.91		.17	Mean
	.04	.04	.20	.05	.24	.05	.05	.00		.14	SDV
413011	9	16	9	7	18	8	6	1	10	84	Count
	.14	.12	.23	1.44	.41	.12	.18	.59	.08	.31	Mean
	.10	.09	.22	.56	.22	.16	.29	.00	.03	.23	SDV
							NO_3 + NO_2-N				
463001	7	9	8	8	10	5	5			52	Count
	2.31	1.56	1.17	2.78	4.70	1.26	1.14			2.32	Mean
	.91	.18	.11	1.25	2.31	.45	.44			1.21	SDV
413011	8	13	8	5	15	5	3		10	67	Count
	.40	.30	.15	.72	.91	.08	.21		.64	.49	Mean
	.31	.25	.09	.24	.35	.10	.33		.18	.26	SDV
							Total Organic Carbon				
463001		7	9	9	15	10	7	1		58	Count
		11.64	9.44	11.67	15.20	7.30	9.43	14.50		11.26	Mean
		4.06	2.94	2.18	2.05	2.38	1.57	.00		2.55	SDV
413011		9	9	7	17	8	6	1		57	Count
		9.56	7.44	15.71	9.97	12.12	8.50	28.50		10.69	Mean
		3.92	1.91	3.47	2.27	11.70	4.59	.00		5.24	SDV
							Chloride				
463001	8	12	9	9	15	10	7	1		71	Count
	33.87	31.04	35.56	34.11	40.47	29.30	30.43	48.00		34.25	Mean
	6.96	3.49	20.29	7.36	6.19	4.24	5.47	.00		8.98	SDV
413011	9	16	9	7	18	8	6	1	10	84	Count
	190.44	96.94	146.22	1565.71	583.06	140.63	563.83	1120.00	57.40	383.79	Mean
	65.36	48.56	100.20	666.90	574.52	53.55	1071.33	.00	11.28	434.97	SDV

Table II-A-28. Concentrations of metals during non-events in the predominantly single land use monitoring sites during Spring 1976

STORET number	Fe	Al	Ni	Cr	Pb	Zn	Cu	Cd	
463001	2	2	2	2	2	2	2	2	Count
	1.10	.038	.01	.002	.002	.010	.006	.0001	Mean
	.28	.019	.00	.00	.00	.00	.001	.00	SDV
413011	3	2	2	3	3	3	3	3	Count
	1.70	.072	.01	.002	.032	.053	.013	.0004	Mean
	.87	.003	.00	.00	8.08	.025	.010	.0004	SDV

For Tables II-A-1 to II-A-28, water flow is given in cms and all other parameters except pH are in mg/L.

Table II-A-29. Bacterial counts in non-event and event samples collected at three predominantly single land use monitoring sites

STORET number	Date	Time	Bacteria counts* (x100)		
			Total coliform	Fecal coliform	Fecal streptococcus
Non-event					
463001	750609			8.3	
413011	"			5.5	
413010	"			2.4	
463001	761004		85	25	37
413011	"		200	3.4	5.9
463001	771019		6.5	2.0	0.6
413011	"		4.5	2.3	0.8
413010	"		3.5	0.5	0.6
Event					
463001	750617			22	
413011	"	1045		32	
413010	"	1800		160	
463001	750624	1035	42	14	43
413011	"	1055	650	150	1,200
413010	"	1445	1,300	400	1,100
463001	750904	0945	45	53	14
413011	"	1010	38	43	150
413010	"	1315	1,300	74	110
413011	770912	1155	2,000	360	550
	"	1535		150	180
	"	1620	700	310	460
	"	1705	700	210	320
	"	1830	440	83	200
	"	1900	1,000	140	220
	"	2115	420	140	200
	"	2315	1,300	100	160
413010	770912	1255	350	100	240
	"	1300	3,000	500	600
	"	1305	800	250	1,900
	"	1340	850	370	650

*Total coliforms are expressed as MFCC/100 ml, fecal coliforms correspond to MFFCC/100 ml and fecal streptococci are in counts/100 ml.
MFCC is membrane filtered coliform counts.
MFFCC is membrane filtered fecal coliform counts.

Table II-A-30. Concentrations of PCBs during events at the predominantly single land use monitoring sites

STORET no.	Event date	Sample size*, L	PCB, µg/L 1242	PCB, µg/L 1254	PCB, µg/L Total
413616	770605	2.34	4.30	3.60	7.90
	770628	2.26	0.243	0.951	1.19
	770724	2.36	**	0.432	
	770803	2.34	0.991	<0.021	0.991
413615	770605	2.38	1.90	3.70	5.60
	770724	2.10	0.111	0.253	0.364
	770803	2.23	<0.022	0.076	0.076
	770813	1.79	0.083	**	
	770904	1.64	0.134	0.153	0.287
413034	770804	1.94	0.115	0.167	0.282
	770808	1.60	<0.031	<0.031	<0.031
683089	770605	2.31	<0.021	<0.021	<0.021
413614	770605	1.74	0.201	**	
	770724	1.66	<0.030	<0.030	<0.030
	770930	1.65	<0.030	<0.030	<0.030
413625	770630	1.23	<0.040	<0.040	<0.040
	770813	2.35	0.071	0.088	0.159
	770828	2.38	<0.021	<0.021	<0.021
	770924	2.38	<0.021	<0.021	<0.021
683090	770724	0.99	<0.050	<0.050	<0.050
	770813	2.38	<0.021	<0.021	<0.021
	770828	1.97	<0.025	<0.025	<0.025
	770924	1.61	<0.031	<0.031	<0.031
	771007	1.99	<0.025	<0.025	<0.025

*Detection limit varies from 0.021 to 0.050 µg/L because of different sample size volumes.

**Resolution is insufficient to make quantitation.

Table II-A-31. Comparison of mean concentration of selected parameters during events in 1976 and 1977 with water quality criteria at the predominantly single land use monitoring sites

Parameter	Water quality criteria*, mg/L		Mean concentration (mg/L) at station:									
	Domestic water supply	Aquatic life	413010	413011	413034	413614	413615	413616	413625	463001	689089	683090
Suspended solids		80	261	154	217	164	341	293	227	257	205	27
Total P		0.05+	0.48 (99)†	0.21 (96)	0.43 (100)	0.34 (95)	0.42 (100)	1.02 (100)	0.33 (100)	0.46 (98)	0.26 (93)	0.36 (100)
NH_3-N	0.5	1.6	0.19 (0)	0.19 (0)	0.21 (0)	0.29 (0)	0.45 (0)	0.08 (0)	0.13 (0)	0.32 (0)	0.25 (0)	0.12 (0)
NO_2+NO_3-N	10		0.79 (0)	0.78 (0)	1.20 (0)	0.01 (0)	1.59 (0)	0.54 (0)	0.58 (0)	3.81 (0.9)	1.01 (0)	0.70 (0)
Chloride	250		158 (16)	141 (15)	41 (2.1)	112 (14)	278 (24)	47 (0)	61 (0)	37 (0)	57 (8.6)	63 (0)
Cd	0.01	0.012	0.011 (5.1)	0.001 (0.6)	0.005 (13)	0.006 (13)	0.007 (19)	0.019 (61)	0.005 (14)	0.002 (3.1)	0.006 (10)	0.004 (12)
Cu	1.0	0.047++	0.17 (2.6)	0.05 (0)	0.10 (1.4)	0.04 (0)	0.16 (0)	0.23 (1.9)	0.04 (0)	0.05 (0)	0.05 (0.7)	0.03 (0)
Pb	0.05	4.82++	0.37 (97)	0.09 (60)	0.52 (100)	0.27 (72)	1.66 (100)	1.34 (97)	0.19 (88)	0.06 (58)	0.44 (90)	0.06 (60)
Zn	5.0	0.082++	0.26 (0)	0.11 (0)	0.32 (0)	0.41 (0)	0.74 (0)	2.40 (13)	0.21 (0)	0.11 (0)	0.24 (0)	0.13 (0)
Cr	0.05	0.10	0.032 (14)	0.012 (1.9)	0.023 (13)	0.015 (4.4)	0.034 (19)	0.083 (46)	0.012 (2.0)	0.017 (9.4)	0.033 (9.8)	0.004 (0)
As	0.05		0.005 (0)	0.005 (0)	0.003 (0)	0.008 (1.9)	0.006 (0)	0.012 (1.3)	0.004 (0)	0.005 (0)	0.007 (1.3)	0.004 (0)
Fecal coliform	200**		265	156	††	††	††	††	††	30	††	††

*Values are U.S. water quality criteria (8,9) unless otherwise specified.

**Coliform limit for bathing waters expressed as MFFCC/100 ml. MFFCC is membrane filtered fecal coliform counts.

+Values for total P represent concentrations that would limit the growth of noxious plants in streams and lakes (9).

++Criteria for fathead minnows under hard water conditions.

†Percent of samples with concentrations exceeding the domestic water supply and aquatic life (total P only) criteria.

††No sample analyzed for bacteria.

Table 4-II-52. Correlation coefficients (r) for water quality parameter concentrations (Data in 1976 and 1977 were combined for all stations)

Parameter	TS	SS	VSS	TP	SP	TON	NH_3	NO_3	Chl	TOC	Cu	Pb	Zn	Cr	As	Se	Ni	Cd	SiO_2	Fe	Al	Mn	Flow
Total solids (TS)	1.000 (1,091)*																						
Suspended solids (SS)	0.599 (1,091)	1.000 (1,371)																					
Volatile susp. solids (VSS)	0.536 (1,089)	0.860 (1,117)	1.000 (1,117)																				
Total P (TP)	0.480 (1,091)	0.740 (1,371)	0.776 (1,117)	1.000 (1,376)																			
Soluble P (SP)	0.121 (1,070)	0.061 (1,149)	0.119 (1,096)	0.500 (1,154)	1.000 (1,154)																		
Total organic N (TON)	0.449 (1,091)	0.486 (1,170)	0.760 (1,117)	0.091 (1,175)	0.166 (1,154)	1.000 (1,175)																	
NH_3-N (NH_3)	0.326 (1,091)	0.196 (1,170)	0.185 (1,117)	0.140 (1,175)	0.120 (1,154)	0.337 (1,175)	1.000 (1,175)																
NO_2 + NO_3 - N (NO_3)	0.138 (1,091)	0.013 (1,170)	0.017 (1,117)	0.006 (1,175)	-0.063 (1,154)	0.181 (1,175)	0.266 (1,175)	1.000 (1,175)															
Chloride (Chl)	0.700 (1,081)	-0.062 (1,133)	-0.042 (1,105)	-0.042 (1,136)	0.036 (1,113)	0.003 (1,136)	0.298 (1,136)	0.078 (1,136)	1.000 (1,136)														
Total organic C (TOC)	0.383 (668)	0.512 (689)	0.720 (676)	0.583 (698)	0.147 (687)	0.728 (699)	0.303 (699)	0.067 (699)	0.088 (678)	1.000 (699)													
Cu	0.376 (775)	0.557 (1,060)	0.421 (796)	0.562 (1,061)	0.190 (836)	0.355 (866)	0.027 (866)	0.032 (866)	0.016 (821)	0.275 (480)	1.000 (1,164)												
Pb	0.458 (776)	0.698 (1,039)	0.822 (793)	0.589 (1,040)	0.083 (835)	0.524 (845)	0.131 (845)	0.089 (845)	0.029 (820)	0.631 (479)	0.672 (1,163)	1.000 (1,163)											
Zn	0.358 (775)	0.531 (1,060)	0.446 (796)	0.700 (1,061)	0.352 (836)	0.367 (866)	-0.050 (866)	-0.050 (866)	-0.033 (821)	0.435 (480)	0.652 (1,164)	0.484 (1,162)	1.000 (1,164)										
Cr	0.220 (775)	0.287 (1,060)	0.306 (796)	0.386 (1,061)	0.142 (836)	0.175 (866)	-0.032 (866)	-0.010 (866)	-0.008 (821)	0.277 (480)	0.262 (1,164)	0.321 (1,163)	0.397 (1,164)	1.000 (1,164)									
As	0.362 (680)	0.576 (865)	0.517 (607)	0.575 (866)	0.179 (707)	0.338 (716)	-0.013 (716)	-0.009 (716)	-0.009 (716)	0.095 (435)	0.460 (950)	0.488 (949)	0.578 (950)	0.264 (950)	1.000 (950)								
Se	0.303 (160)	0.442 (169)	0.442 (169)	0.520 (169)	0.454 (160)	0.271 (169)	-0.160 (169)	-0.111 (169)	-0.130 (169)	-0.067 (129)	0.155 (210)	0.390 (210)	0.444 (210)	0.064 (210)	0.636 (210)	1.000 (210)							
Ni	0.311 (680)	0.592 (865)	0.560 (607)	0.569 (866)	0.172 (707)	0.393 (716)	-0.033 (716)	-0.006 (716)	-0.058 (716)	0.194 (435)	0.447 (950)	0.519 (949)	0.615 (950)	0.295 (950)	0.680 (950)	0.540 (210)	1.000 (950)						
Cd	0.152 (773)	0.206 (1,037)	0.249 (792)	0.311 (1,038)	0.139 (836)	0.160 (844)	-0.015 (844)	-0.037 (844)	0.016 (819)	0.108 (479)	0.711 (1,161)	0.262 (1,160)	0.395 (1,161)	0.107 (1,161)	0.235 (947)	0.152 (210)	0.226 (947)	1.000 (1,161)					
Dissolved SiO_2	0.246 (739)	0.050 (1,000)	0.004 (750)	0.390 (1,001)	0.507 (801)	0.015 (810)	-0.060 (810)	0.060 (810)	0.093 (705)	0.170 (467)	0.167 (1,111)	0.116 (1,110)	0.339 (1,111)	0.337 (1,111)	0.202 (960)	0.102 (209)	0.168 (960)	0.146 (1,108)	1.000 (1,111)				
Fe	0.380 (775)	0.444 (1,060)	0.618 (796)	0.576 (1,061)	0.162 (836)	0.354 (866)	0.029 (866)	0.069 (866)	-0.063 (821)	0.195 (480)	0.672 (1,164)	0.652 (1,163)	0.667 (1,164)	0.276 (1,164)	0.579 (950)	0.322 (210)	0.527 (950)	0.233 (1,161)	0.167 (1,111)	1.000 (1,164)			
Al	0.376 (775)	0.403 (1,060)	0.581 (796)	0.448 (1,061)	-0.024 (836)	0.516 (866)	0.143 (866)	0.137 (866)	-0.056 (821)	0.403 (480)	0.365 (1,151)	0.387 (1,150)	0.266 (1,151)	0.216 (1,151)	0.376 (949)	0.107 (209)	0.411 (949)	0.111 (1,148)	-0.020 (1,110)	0.637 (1,151)	1.000 (1,151)		
Mn	0.387 (775)	0.607 (1,060)	0.636 (796)	0.701 (1,061)	0.314 (836)	0.351 (866)	-0.028 (866)	0.006 (866)	-0.067 (821)	0.213 (480)	0.604 (1,152)	0.448 (1,151)	0.839 (1,152)	0.339 (1,152)	0.620 (950)	0.715 (210)	0.596 (950)	0.322 (1,149)	0.275 (1,111)	0.878 (1,152)	0.667 (1,151)	1.000 (1,152)	
Flow	0.110 (1,091)	0.326 (1,371)	0.229 (1,117)	0.253 (1,376)	0.119 (1,154)	0.091 (1,175)	-0.005 (1,175)	0.002 (1,175)	-0.119 (1,136)	-0.008 (699)	0.210 (1,164)	0.197 (1,163)	0.277 (1,164)	0.174 (1,164)	0.262 (950)	0.305 (210)	0.261 (950)	0.095 (1,161)	-0.002 (1,111)	0.260 (1,164)	0.286 (1,151)	0.290 (1,152)	1.000 (1,518)

( ) Number of samples (n) correlated.
Significant values of r at various error d.f.:

d.f.(n-2)	P = 0.05	P = 0.01
100	0.195	0.254
200	0.138	0.181
300	0.113	0.148
400	0.098	0.128
500	0.088	0.115
1,000	0.062	0.081

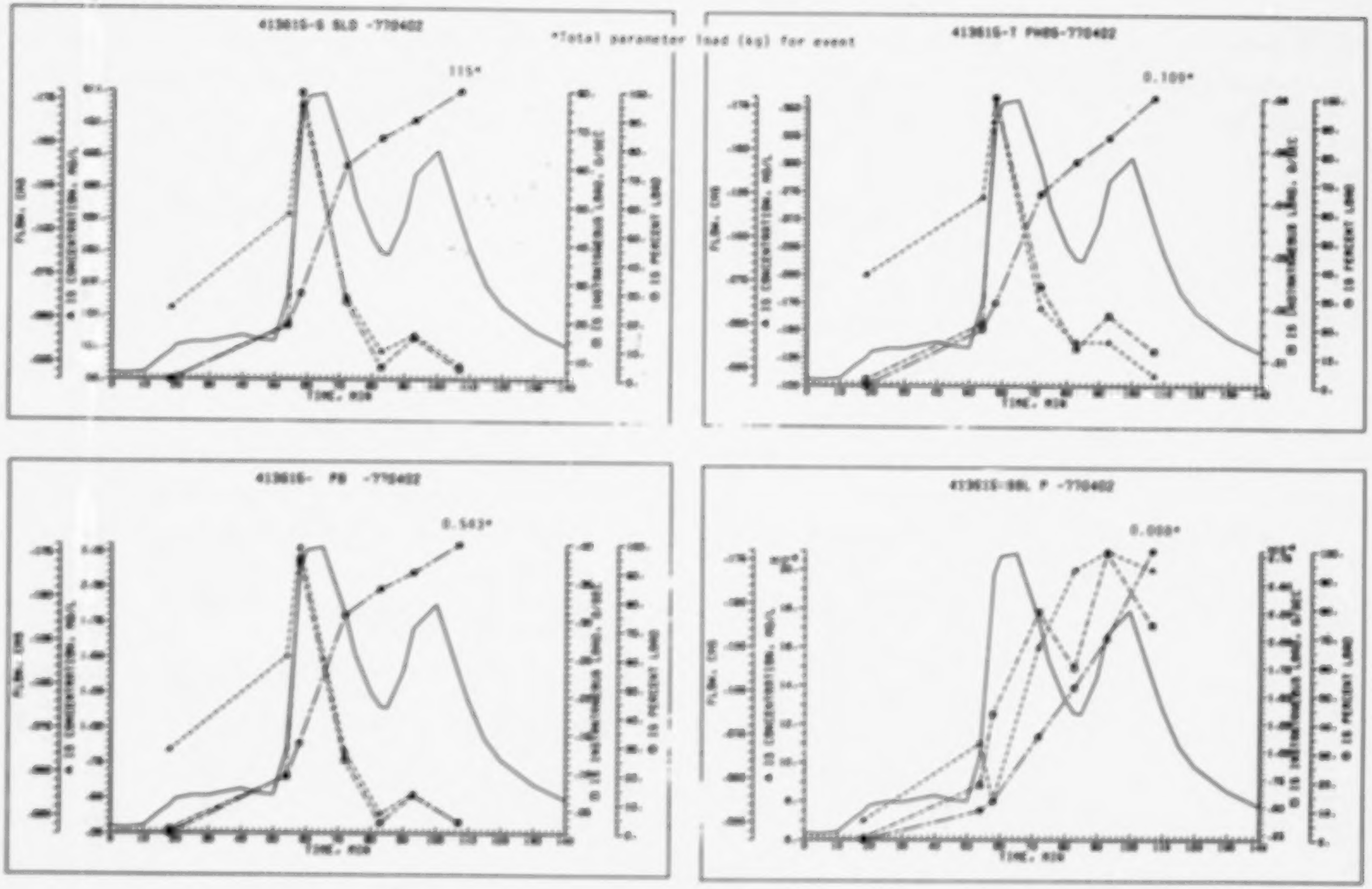
Table II-A-33. Correlation coefficients (r) for selected water quality parameter concentrations during spring and summer of 1977 at the predominantly single land use monitoring sites

	Spring					Summer				
Parameter	Total P	Soluble P	Pb	Cd	Suspended solids	Total P	Soluble P	Pb	Cd	Suspended solids
STORET no. 683089										
Total P	1.000 (23)*					1.000 (80)				
Soluble P	0.420* (23)	1.000 (23)				0.408** (55)	1.000 (55)			
Pb	0.796** (23)	0.250 (23)	1.000 (24)			0.302** (80)	-0.018 (55)	1.000 (84)		
Cd	0.867** (23)	0.618** (23)	0.770** (24)	1.000 (24)		0.061 (80)	-0.067 (55)	0.220* (84)	1.000 (84)	
Suspended solids	0.896** (23)	0.365 (23)	0.963** (23)	0.838** (23)	1.000 (23)	0.324** (80)	-0.072 (55)	0.775** (80)	0.230* (80)	1.000 (80)
Flow	-0.039 (23)	-0.190 (23)	0.173 (24)	-0.128 (24)	0.040 (23)	-0.093 (80)	-0.230 (55)	-0.015 (84)	0.037 (84)	0.034 (80)
STORET no. 413615										
Total P	1.000 (79)					1.000 (110)				
Soluble P	0.113 (78)	1.000 (78)				-0.062 (96)	1.000 (96)			
Pb	0.822** (78)	-0.294** (77)	1.000 (92)			0.849** (105)	-0.164 (89)	1.000 (113)		
Cd	0.294* (79)	-0.275* (78)	0.463** (90)	1.000 (93)		0.577** (105)	-0.261* (89)	0.658** (113)	1.000 (113)	
Suspended solids	0.829** (79)	-0.343** (78)	0.933** (78)	0.442** (78)	1.000 (79)	0.898** (110)	-0.069 (94)	0.903** (105)	0.601** (105)	1.000 (110)
Flow	0.533** (79)	-0.383** (78)	0.624** (92)	0.295** (93)	0.697** (79)	0.677** (110)	0.105 (94)	0.620** (113)	0.157 (113)	0.532** (110)
STORET no. 413616										
Total P	1.000 (40)					1.000 (88)				
Soluble P	0.586** (40)	1.000 (40)				0.351** (74)	1.000 (74)			
Pb	0.958** (39)	0.553** (39)	1.000 (39)			0.902** (85)	0.080 (74)	1.000 (87)		
Cd	0.814** (39)	0.537** (39)	0.859** (39)	1.000 (39)		0.806** (84)	-0.003 (73)	0.765** (86)	1.000 (86)	
Suspended solids	0.972** (40)	0.486** (40)	0.970** (39)	0.827** (39)	1.000 (40)	0.926** (88)	0.130 (74)	0.967** (85)	0.809** (86)	1.000 (88)
Flow	0.663** (40)	0.404** (40)	0.729** (39)	0.555** (39)	0.710** (40)	0.651** (88)	0.161 (76)	0.368** (87)	0.447** (86)	0.676** (88)
STORET no. 413010										
Total P	1.000 (7)					1.000 (46)				
Soluble P	-0.606 (7)	1.000 (7)				-0.059 (46)	1.000 (46)			
Pb	0.875** (6)	-0.140 (6)	1.000 (6)			0.812** (41)	0.052 (41)	1.000 (43)		
Cd	0.630 (6)	-0.244 (6)	-0.677 (6)	1.000 (6)		0.436** (41)	-0.369* (41)	0.368* (43)	1.000 (43)	
Suspended solids	0.981** (7)	-0.524 (7)	0.968** (6)	-0.524 (6)	1.000 (19)	0.976** (46)	-0.005 (46)	0.760** (43)	0.353* (43)	1.000 (58)
Flow	0.064 (7)	0.588 (7)	0.535 (6)	-0.207 (6)	0.576** (19)	0.390** (46)	0.076 (46)	0.626** (43)	0.017 (43)	0.423** (58)

Table II-A-33. Continued

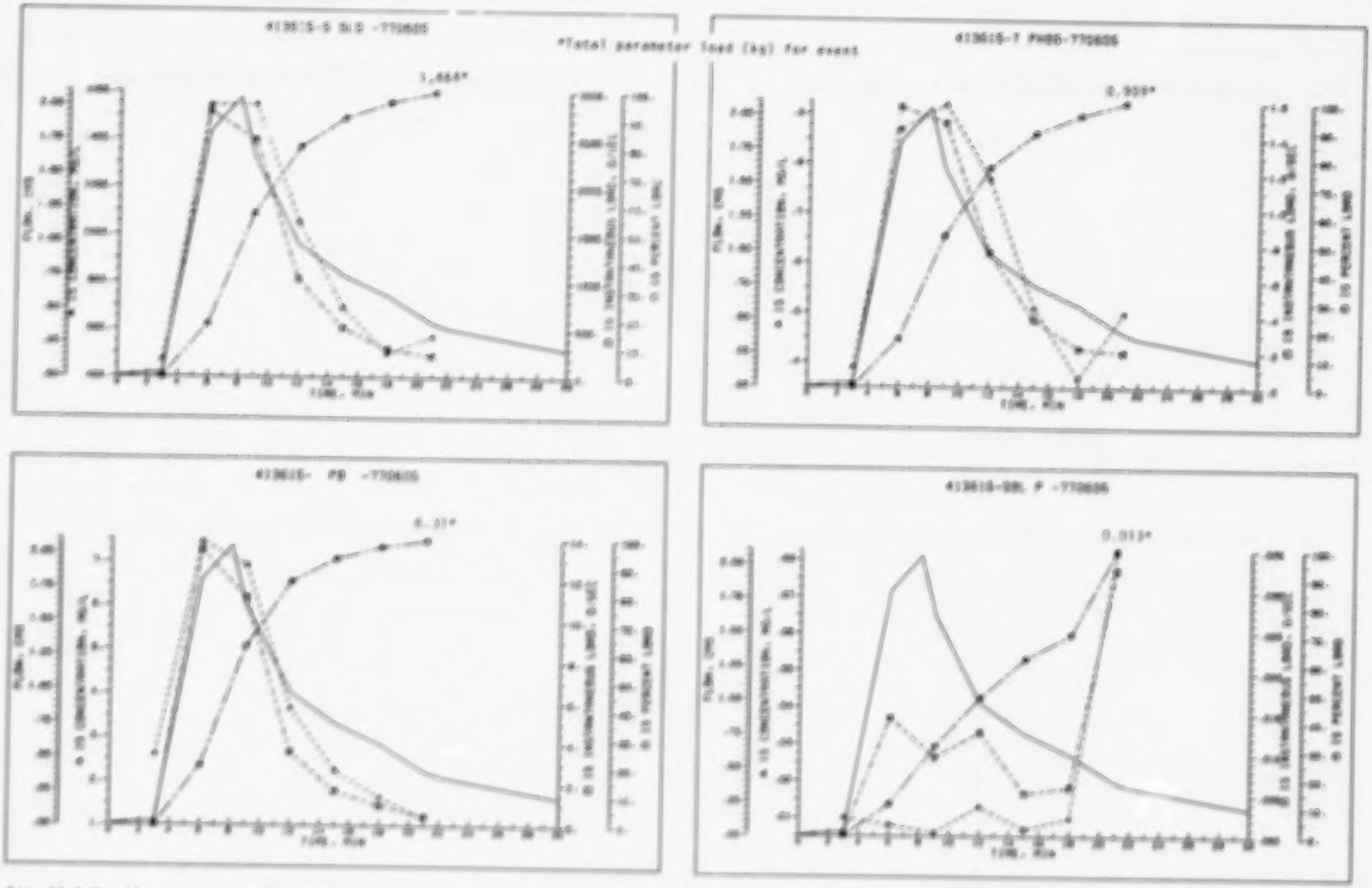
Parameter	Spring					Summer				
	Total P	Soluble P	Pb	Cd	Suspended solids	Total P	Soluble P	Pb	Cd	Suspended solids
					STORET no. 613011					
Total P	1.000 (44)					1.000 (71)				
Soluble P	0.572** (44)	1.000 (44)				0.336** (70)	1.000 (70)			
Pb	0.901** (43)	0.488** (43)	1.000 (43)			0.561** (60)	-0.088 (59)	1.000 (61)		
Cd	0.536** (43)	-0.039 (43)	0.467** (43)	1.000 (43)		-0.067 (59)	-0.144 (58)	0.186 (60)	1.000 (60)	
Suspended solids	0.943** (44)	0.413** (44)	0.874** (43)	0.647** (43)	1.000 (120)	0.942** (69)	0.160 (68)	0.607** (61)	-0.109 (60)	1.000 (136)
Flow	0.852** (44)	0.600** (44)	0.767** (43)	0.656** (43)	0.756** (120)	0.532** (71)	0.555** (70)	0.091 (61)	-0.101 (60)	0.633** (136)
					STORET no. 613625					
Total P	1.000 (7)					1.000 (30)				
Soluble P	0.997** (7)	1.000 (7)				0.287 (15)	1.000 (15)			
Pb	-0.206 (7)	-0.269 (7)	1.000 (9)			0.743** (30)	0.318 (15)	1.000 (30)		
Cd	0.610 (7)	0.376 (7)	-0.126 (9)	1.000 (9)		0.082 (30)	0.426 (15)	-0.095 (30)	1.000 (30)	
Suspended solids	0.700 (7)	0.650 (7)	0.510 (7)	0.561 (7)	1.000 (7)	0.921** (30)	0.012 (15)	0.697** (30)	-0.085 (30)	1.000 (30)
Flow	0.965** (7)	0.964 (7)	-0.283 (9)	0.211 (9)	0.846** (7)	0.564** (30)	-0.142 (15)	0.360* (30)	-0.043 (30)	0.613** (30)
					STORET no. 683000					
Total P	1.000 (15)					1.000 (22)				
Soluble P	0.735** (15)	1.000 (15)				0.963** (11)	1.000 (11)			
Pb	-0.185 (15)	-0.570* (15)	1.000 (15)			-0.057 (22)	-0.622* (11)	1.000 (22)		
Cd	0.426 (15)	-0.150 (15)	0.428 (15)	1.000 (15)		-0.094 (22)	-0.466 (11)	0.609** (22)	1.000 (22)	
Suspended solids	0.888** (15)	0.496 (15)	-0.077 (15)	0.447 (15)	1.000 (15)	0.061 (22)	-0.846** (11)	0.260 (22)	0.137 (22)	1.000 (22)
Flow	-0.388 (15)	-0.136 (15)	0.312 (15)	-0.327 (15)	-0.251 (15)	-0.257 (22)	-0.218 (11)	-0.335 (22)	-0.329 (22)	0.073 (22)
					STORET no. 663001[a]					
Total P						1.000 (62)				
Soluble P						0.515** (62)	1.000 (62)			
Pb						-0.301 (30)	-0.234 (30)	1.000 (31)		
Cd						0.141 (29)	0.066 (29)	0.647** (30)	1.000 (30)	
Suspended solids						0.863** (41)	0.264 (41)	-0.275 (31)	0.120 (30)	1.000 (77)
Flow						0.788** (62)	0.655** (62)	-0.315 (31)	0.150 (30)	0.789** (77)

( ) Number of samples (n) correlated.
*Significant at P = 0.05
**Significant at P = 0.01
[a] Not sampled in spring.



*Total parameter load (kg) for event

Fig. II-6-1. Flow and parameter concentrations and loadings for event on April 2, 1977 at Stadium Interchange (413615).



*Total parameter load (kg) for event

Fig. II-4-2. Flow and parameter concentrations and loadings for event on June 5, 1977 at Stadium Interchange (413615).

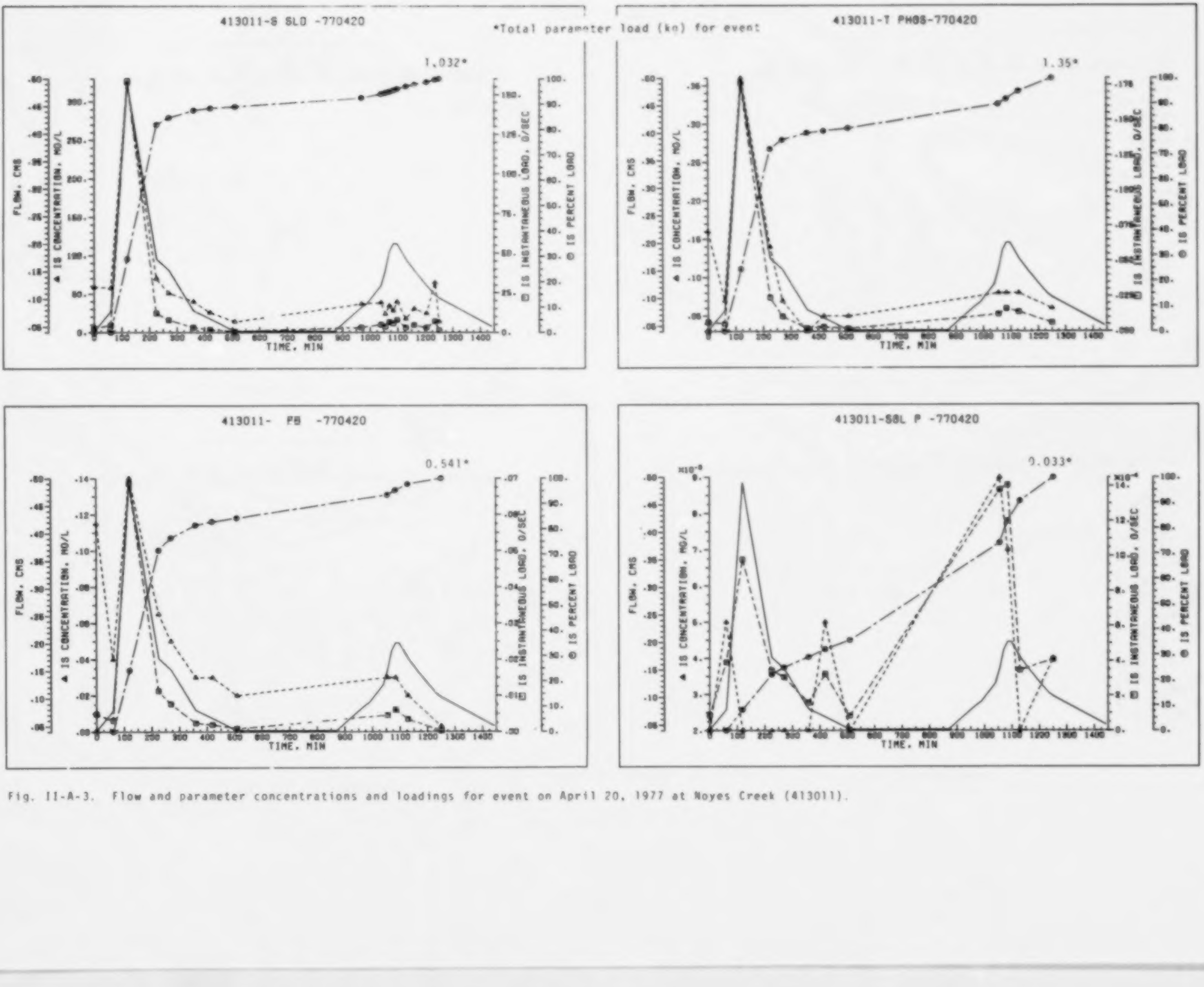
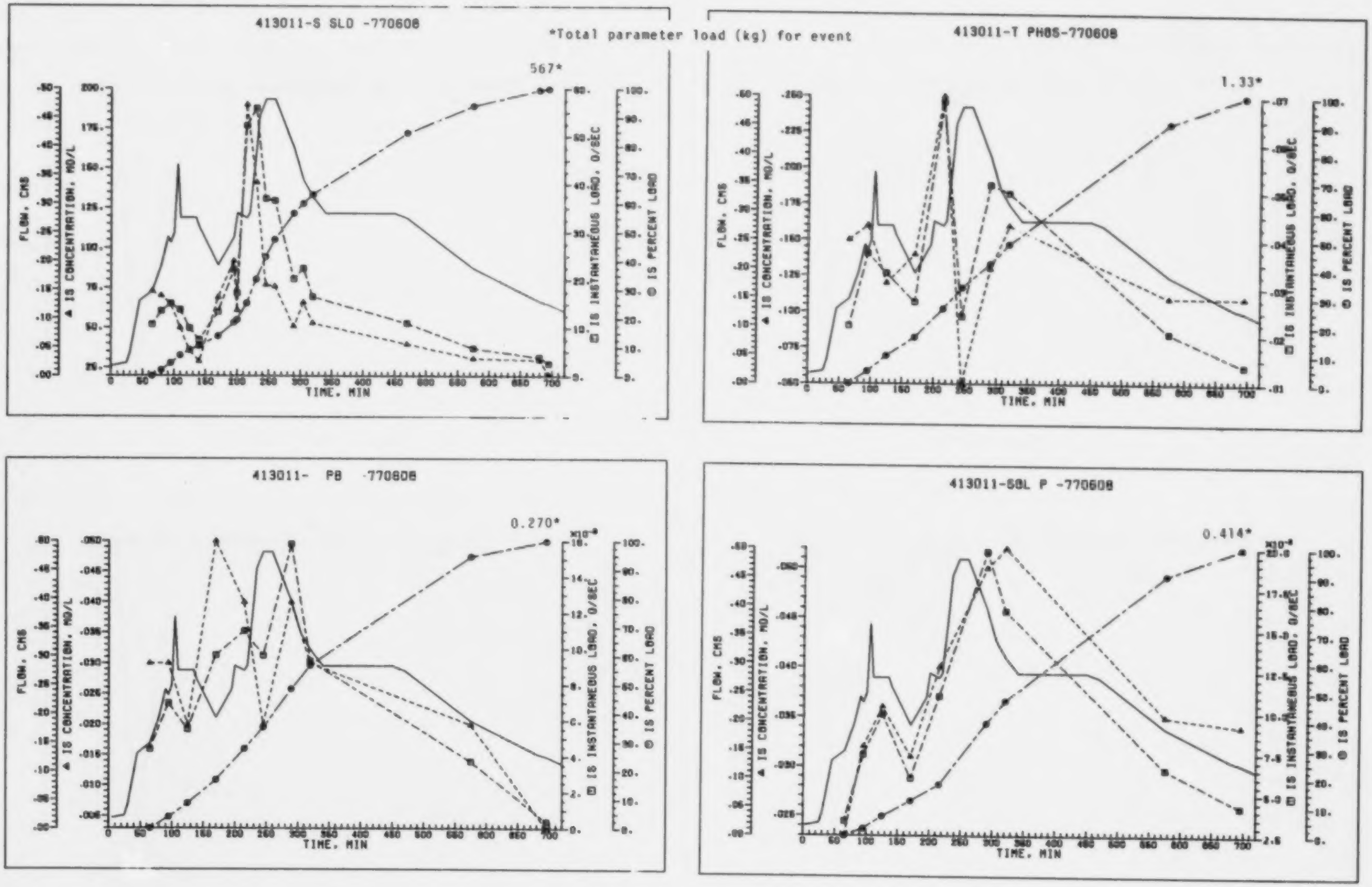
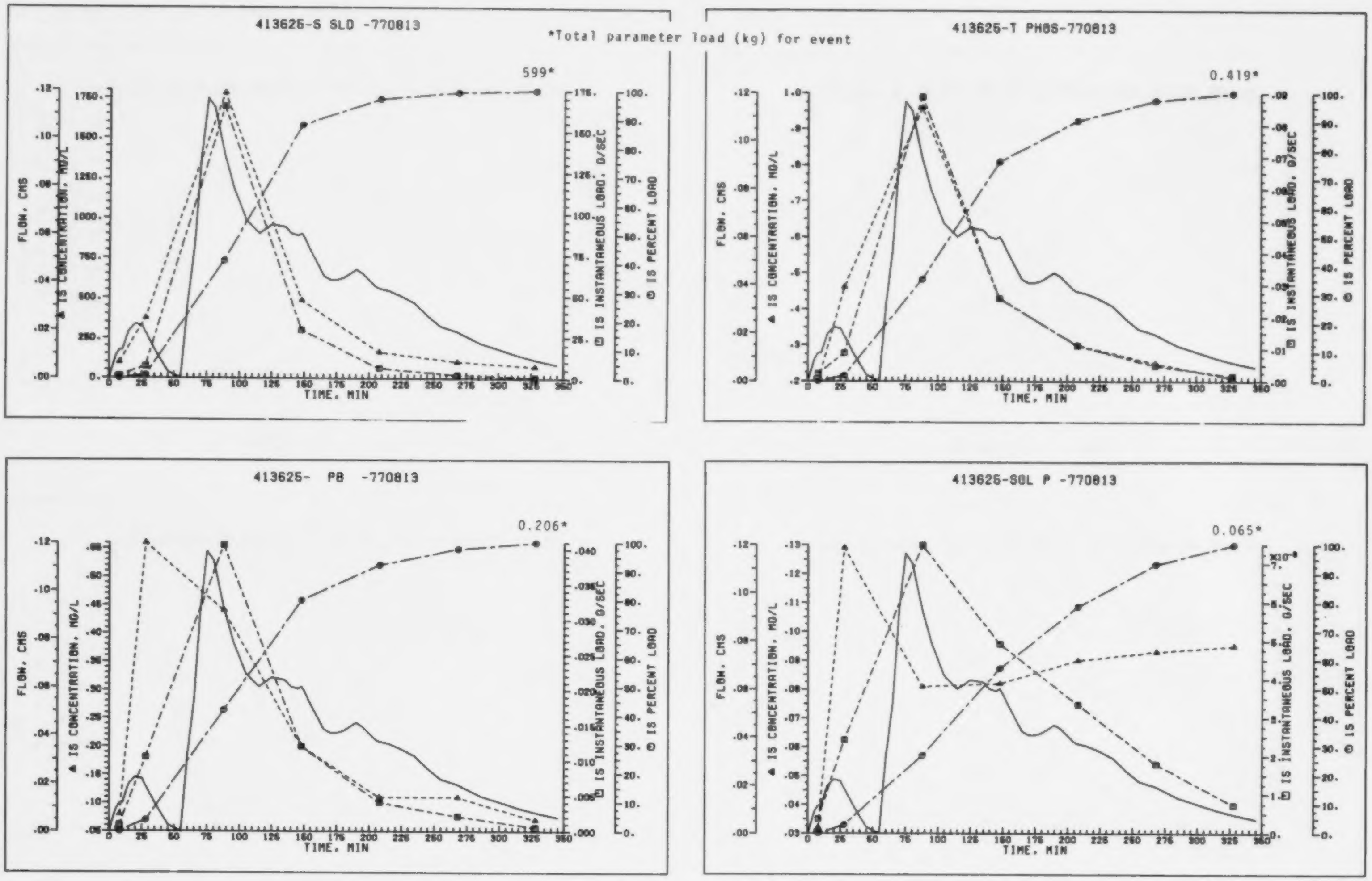


Fig. II-A-3. Flow and parameter concentrations and loadings for event on April 20, 1977 at Noyes Creek (413011).



*Total parameter load (kg) for event

Fig. II-A-4. Flow and parameter concentrations and loadings for event on June 8, 1977 at Noyes Creek (413011).



*Total parameter load (kg) for event

Fig. II-A-5. Flow and parameter concentrations and loadings for event on August 13, 1977 at New Berlin (413625).

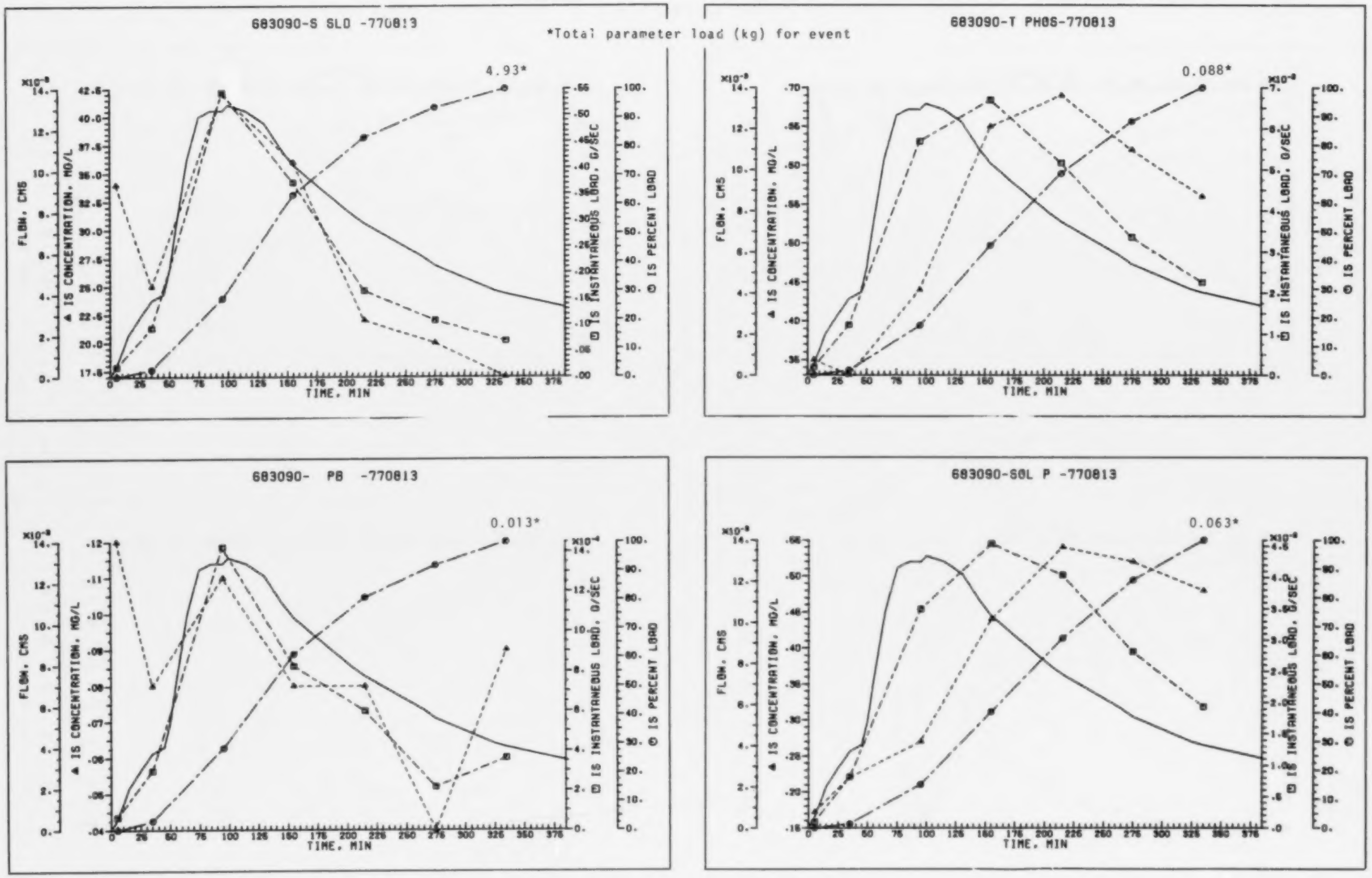
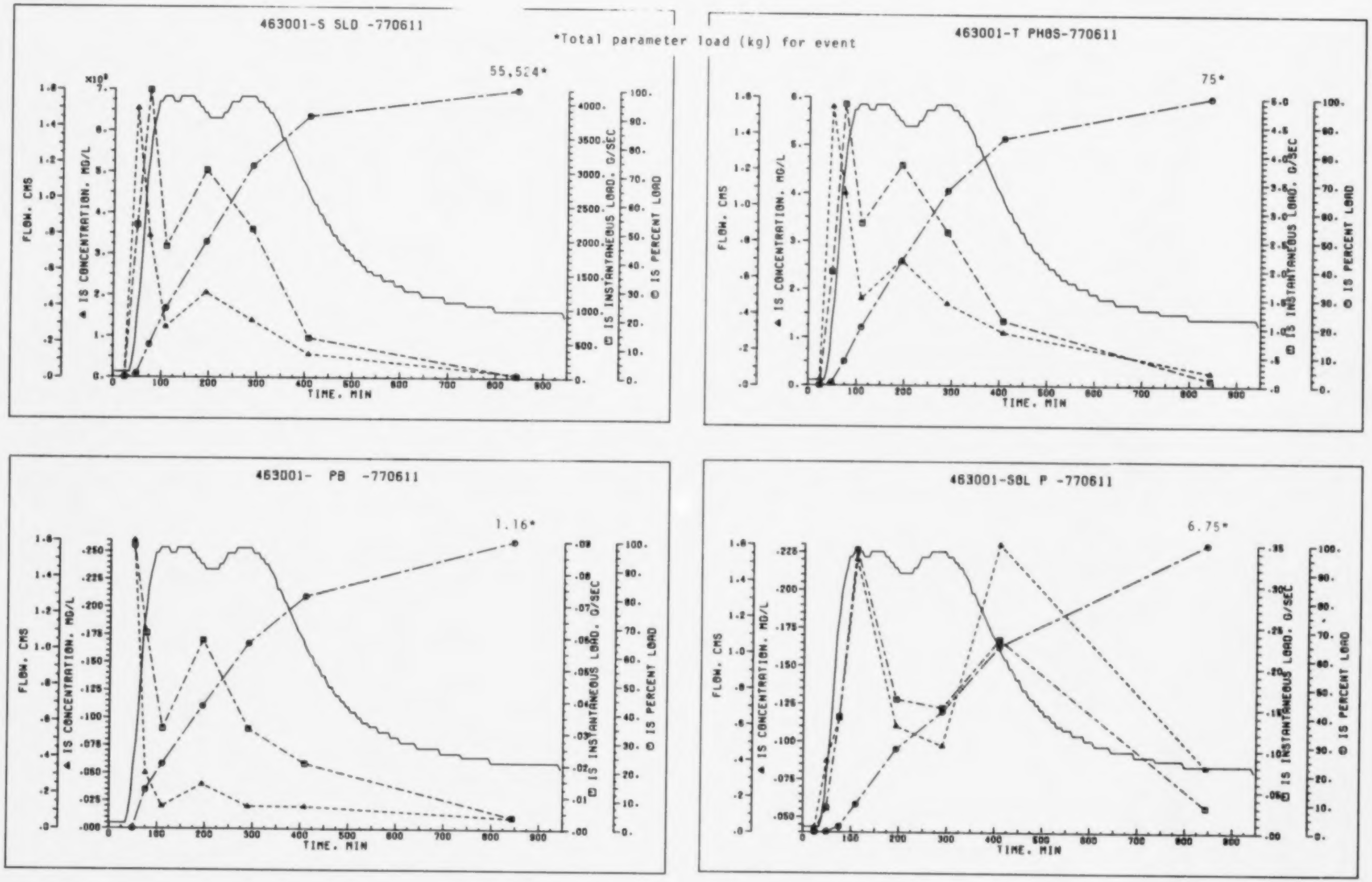

*Total parameter load (kg) for event

Fig. II-A-6. Flow and parameter concentrations and loadings for event on August 13, 1977 at Elm Grove (683090).



*Total parameter load (kg) for event

Fig. II-A-7. Flow and parameter concentrations and loadings for event on June 11, 1977 at Donges Bay (463001).

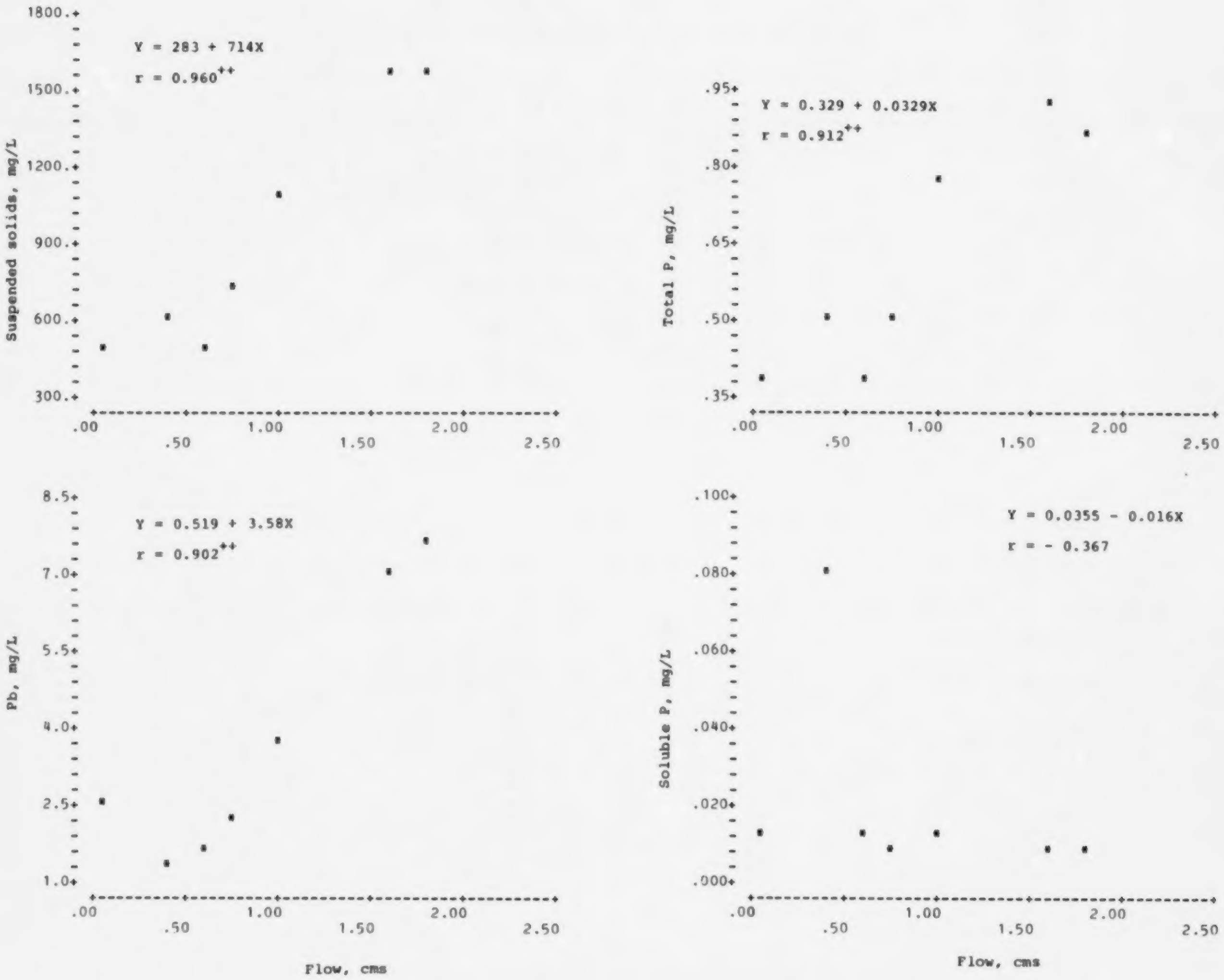


Fig. II-A-8. Relationships of parameter concentrations and flow for event on June 5, 1977 at Stadium Interchange (413615) ($^{++}$Significant at P = 0.01).

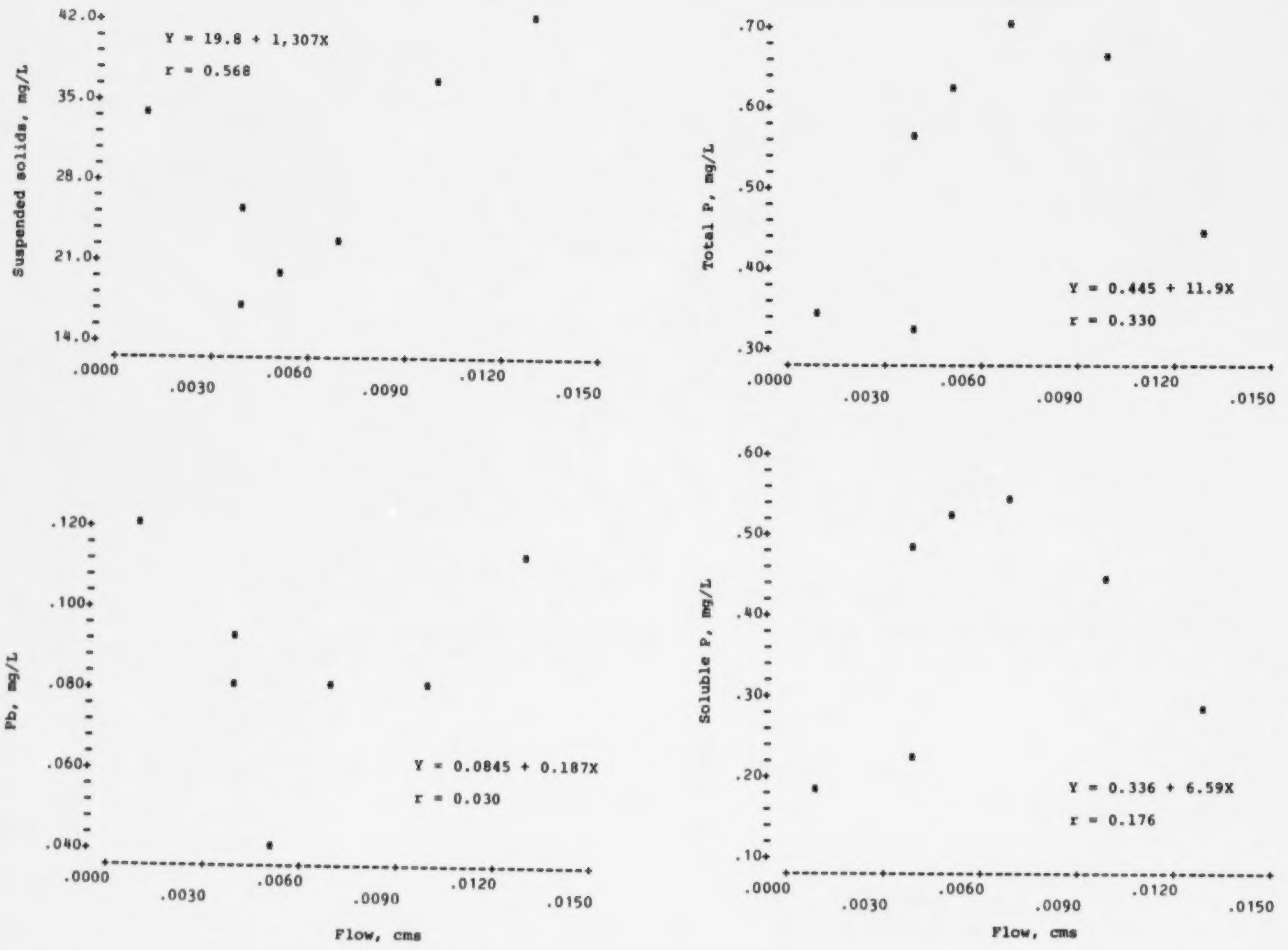


Fig. II-A-9. Relationships of parameter concentrations and flow for event on August 13, 1977 at Elm Grove (683090)

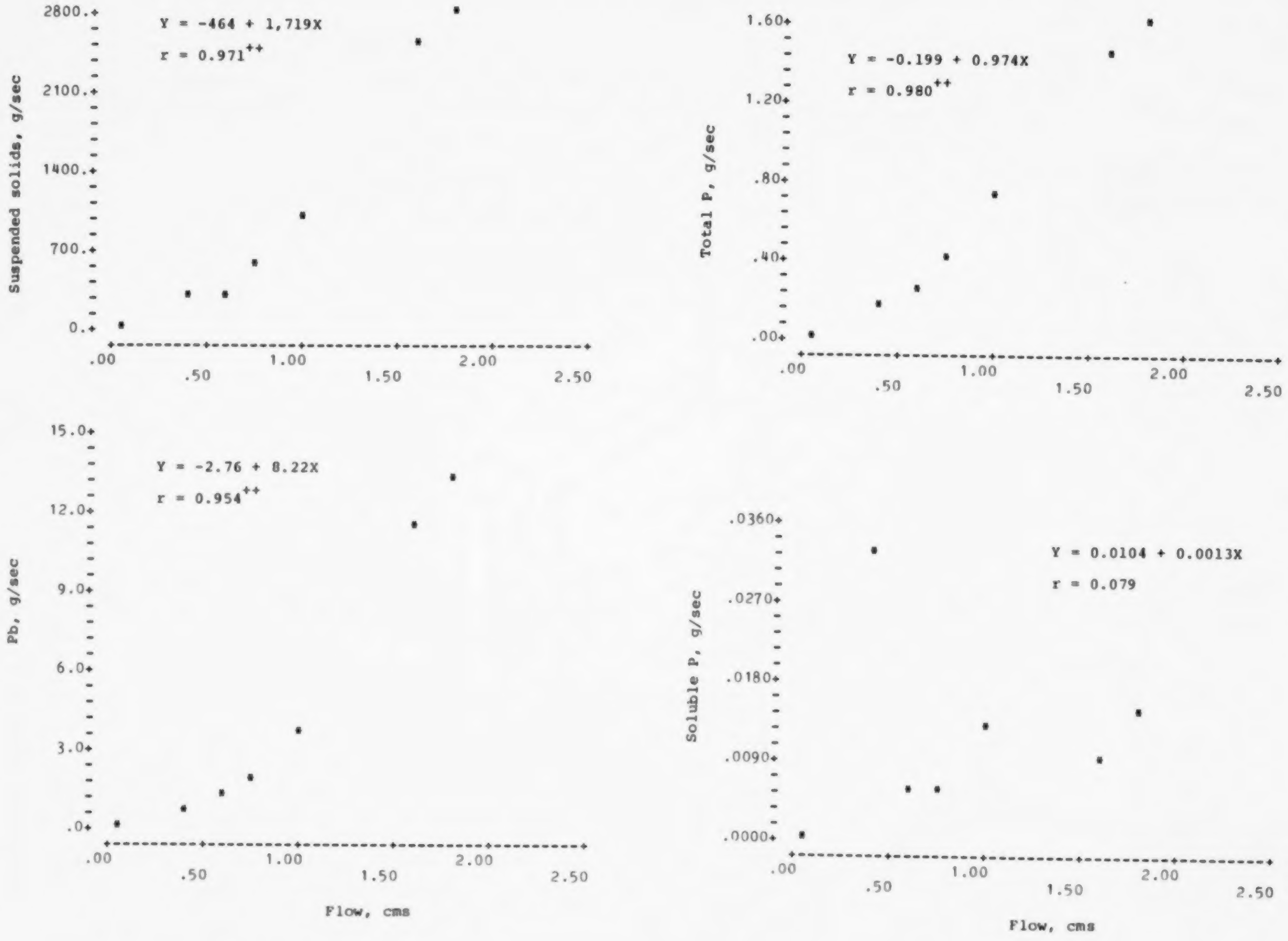


Fig. II-A-10. Relationships of paremeter loading rates and flow for event on June 5, 1977 at Stadium Interchange (413615) ($^{++}$Significant at P = 0.01).

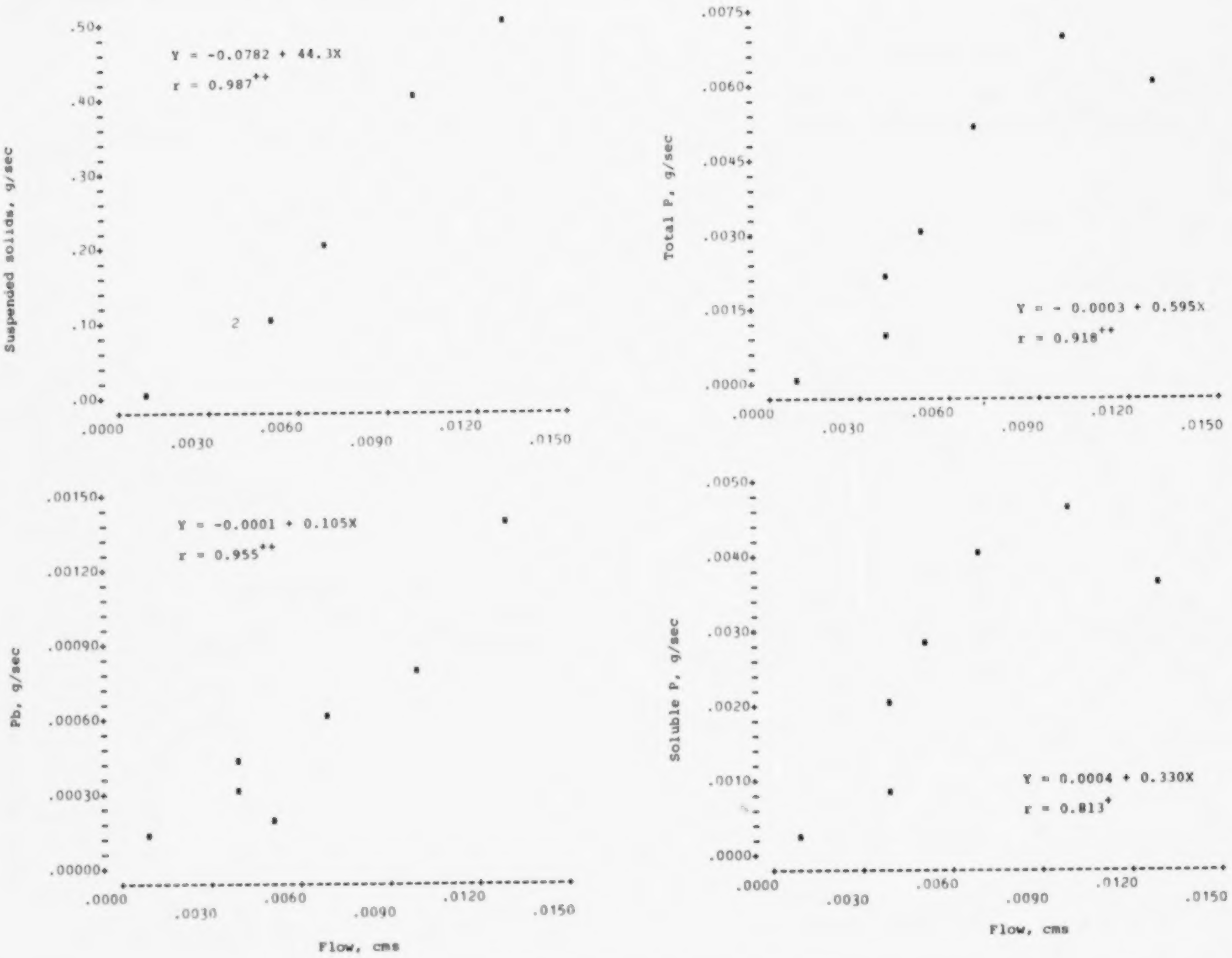


Fig. II-A-11. Relationships of parameter loading rates and flow for event on August 13, 1977 at Elm Grove (683090) ($^+$Significant at $P = 0.05$; $^{++}$significant at $P = 0.01$).

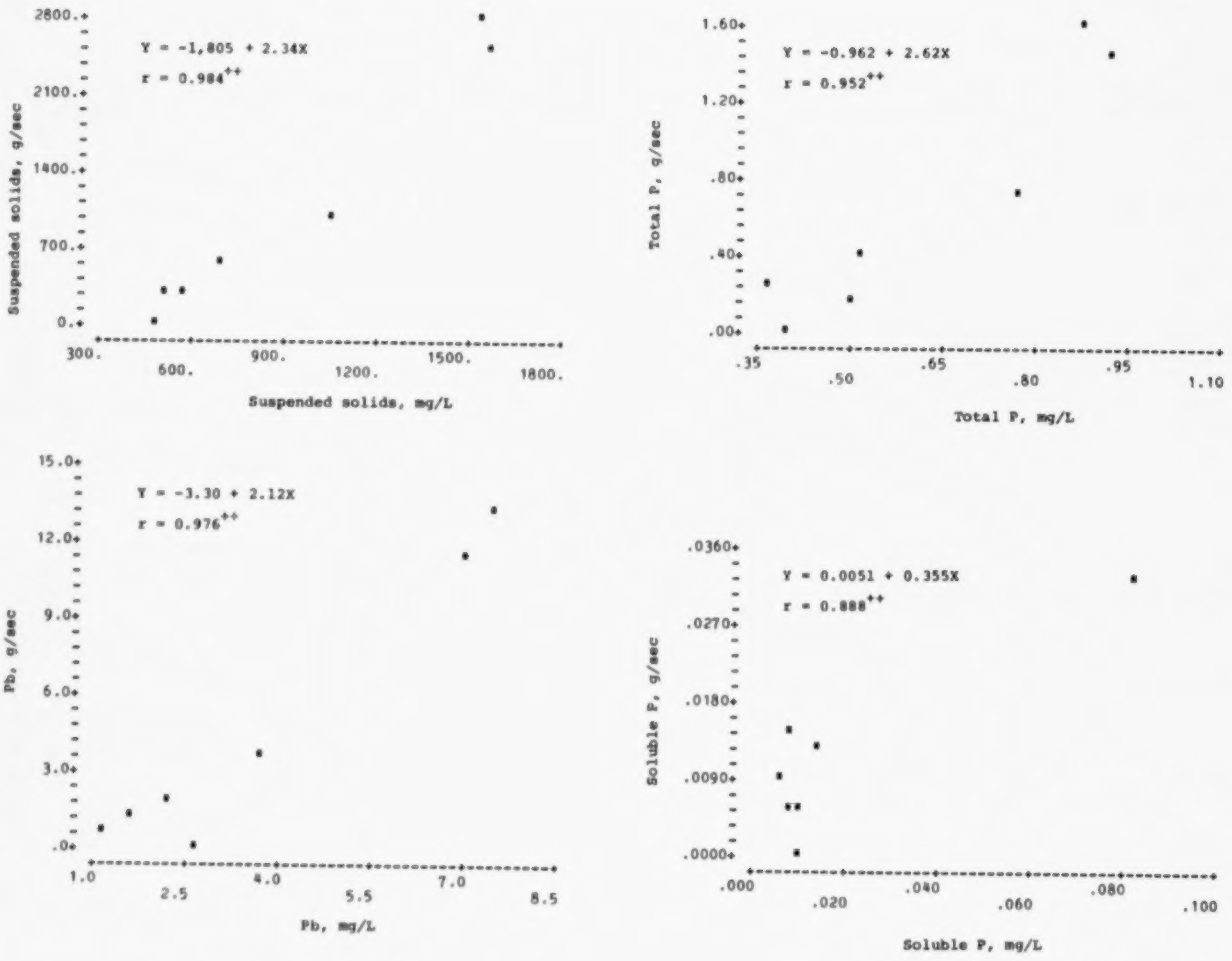


Fig. II-A-12. Relationships of parameter loading rates and parameter concentrations for event on June 5, 1977 at Stadium Interchange (413615) (++Significant at P = 0.01).

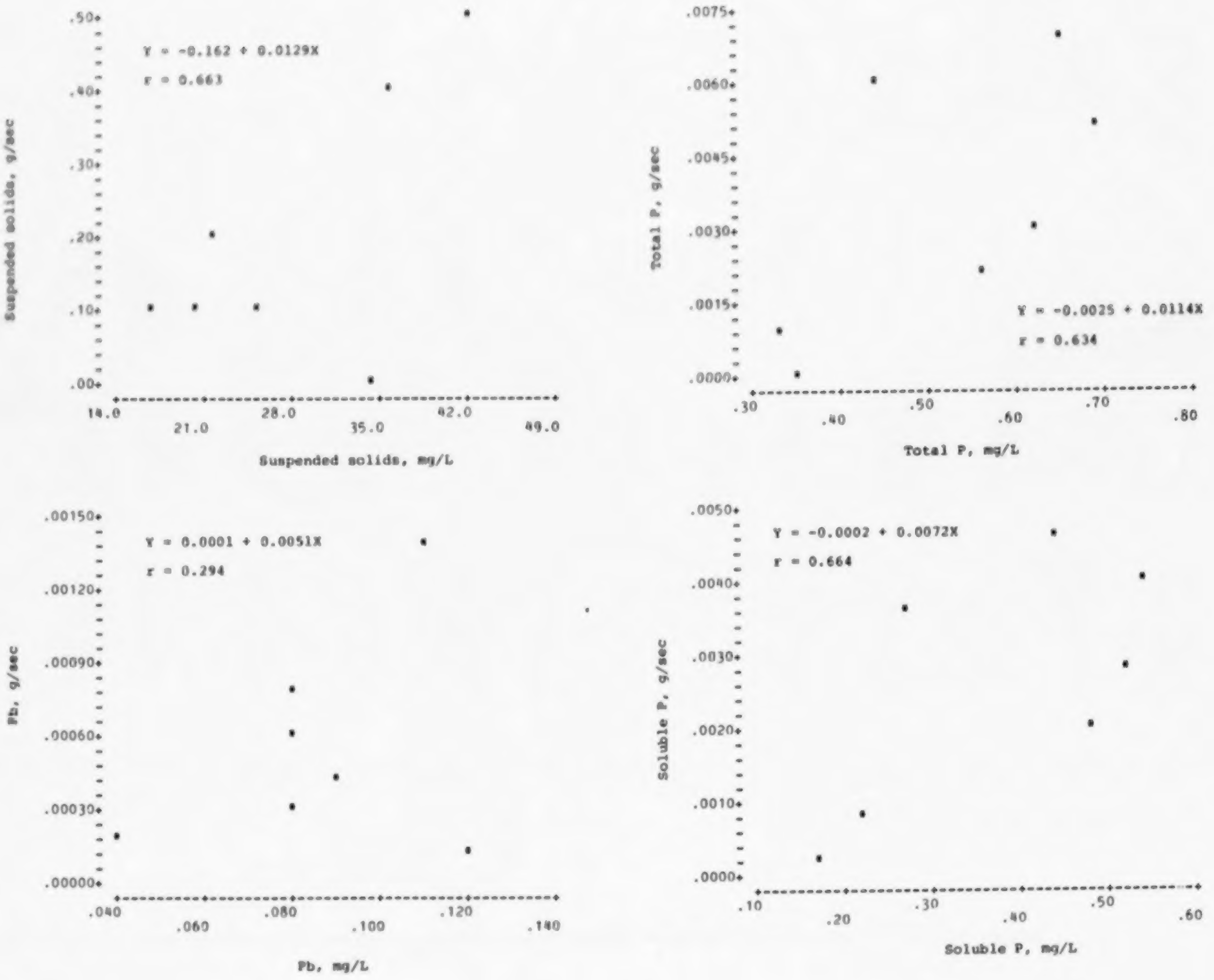


Fig. II-A-13. Relationships of parameter loading rates and parameter concentrations for event on August 13, 1977 at Elm Grove (683090)

Table II-A-34. Flow and parameter concentrations for selected events at Brookfield Square Shopping Center (683089)

			Concentration (mg/l)								: Concentration (ug/l)			
Date	Time	Flow (cfs)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlor-ides	Lead	Cadmium	Zinc	Copper
770402	0107	.100	290.	108.	.80	.54	1.40	.14	.019	66.	460.	17.0	300.	90.
	0906	.012	930.	290.	1.20	.60	1.98	.19	.011	270.	690.	15.0	400.	80.
	0938	.063	260.	149.	.70	.65	1.36	.11	.012	37.	380.	6.0	300.	70.
	1033	.040	445.	63.	.50	.56	1.18	.06	.015	44.	140.	3.0	300.	40.
	1408	.112	1955.	1812.	3.40	.63	.64	.89	.008	42.	2930.	20.0	930.	140.
	1534	.097	370.	222.	1.00	1.03	1.03	.20	.007	38.	630.	7.0	560.	90.
	1717	.017	545.	21.	.60	.39	1.11	.07	.014	198.	120.	10.0	270.	30.
770420	1752	.009	3135.	1640.	3.70	.15	1.81	2.33	.018	500.	1920.	30.0	1130.	1020.
	1956	.031	1950.	1644.	3.90	.32	1.88	1.12	.004	55.	2270.	23.0	1080.	240.
	2007	.658	925.	820.	2.10	.25	1.03	.59	.009	13.	1620.	7.0	780.	140.
	2152	.017	315.	51.	.90	.49	2.60	.15	.048	36.	20.	9.0	430.	40.
770421	1013	.046	170.	36.	.70	.26	1.21	.10	.015	19.	40.	6.0	440.	30.
770617	1920	.007	2430.	1442.	1.50	.35	1.19	1.03	.018	165.	960.	7.0	470.	110.
	1923	.017	975.	709.	1.70	.92	1.59	.41	.064	16.	1060.	5.0	470.	70.
	1931	2.078	425.	303.	1.30	.51	.91	.24	.027	8.	580.	4.0	290.	50.
	1943	1.252	195.	101.	.70	.30	.63	.11	.009	6.	90.	4.0	110.	30.
	2012	.101	185.	49.	.90	.32	1.01	.13	.026	13.	40.	3.0	100.	20.
770618	1305	.009	855.	16.	.50	.07	1.02	.32	.142	115.	30.	1.0	60.	20.
770630	0724	.082	335.	165.	.90	.28	.90	.19	.022	27.	380.	12.0	870.	70.
	0748	1.252	190.	143.	.40	.13	.32	.10	.017	2.	180.	20.0	410.	40.
	0836	.121	110.	63.	.03	.09	.34	.07	.021	4.	290.	14.0	260.	40.
	0857	.081	185.	138.	.50	.07	.28	.09	.015	3.	150.	5.0	60.	30.
	0908	1.010	115.	77.	.40	.04	.20	.06	.024	7.	90.	4.0	110.	40.
	0943	.219	90.	45.	.30	.03	.21	.07	.024	7.	40.	3.0	270.	30.
	1324	.017	390.	18.	.30	.06	.76	.14	.080	54.	750.	2.0	1050.	100.

Table II-A-35. Flow and parameter concentrations for selected events at Stadium Interchange (413615)

			Concentration (mg/l)								Concentration (ug/l)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
770402	0018	.031	2170.	162.	1.50	.40	4.60	.20	.007	850.	840.	11.0	460.	100.
	0054	.063	1005.	308.	1.40	.56	3.00	.27	.011	275.	1510.	5.0	670.	150.
	0058	.167	940.	478.	1.60	.53	1.95	.36	.008	160.	2280.	9.0	930.	200.
	0112	.141	395.	180.	.80	.52	1.44	.17	.016	80.	830.	4.0	380.	110.
	0123	.087	335.	94.	.50	.49	1.29	.14	.020	90.	390.	2.0	290.	60.
	0133	.132	345.	120.	.50	.37	1.06	.14	.021	86.	530.	3.0	290.	60.
	0147	.107	275.	73.	.40	.32	.90	.11	.020	76.	330.	2.0	240.	70.
770420	2004	.024	2730.	1520.	5.40	.25	3.00	1.08	.002	575.	6430.	18.0	2430.	490.
	2007	.381	2670.	2220.	7.30	.49	1.83	1.43	.002	230.	9420.	19.0	3320.	590.
	2009	.374	2265.	1784.	6.40	.52	1.76	1.31	.002	120.	8590.	31.0	2940.	490.
	2012	.320	1900.	1596.	6.50	.62	1.60	1.31	.002	135.	7430.	12.0	2760.	500.
	2014	.219	1560.	1232.	6.20	.59	1.61	1.18	.005	115.	4310.	10.0	2200.	320.
	2017	.176	1245.	964.	5.20	.58	1.66	.59	.005	135.	2890.	8.0	1440.	270.
	2019	.135	970.	648.	4.00	.51	1.70	.74	.002	135.	2040.	5.0	1160.	230.
770605	0253	.033	1820.	472.	2.70	.53	3.30	.39	.010	275.	2600.	22.0	1140.	200.
	0256	1.802	2625.	1544.	4.40	.72	1.21	.87	.008	55.	7460.	13.0	2320.	800.
	0259	1.609	1840.	1548.	4.30	.58	.72	.92	.006	27.	6930.	20.0	1930.	410.
	0302	.979	1820.	1054.	3.70	.38	.62	.77	.013	20.	3680.	9.0	1170.	250.
	0305	.749	1000.	694.	2.60	.26	.66	.51	.007	16.	2260.	9.0	930.	210.
	0308	.601	775.	502.	2.20	.19	.59	.37	.010	17.	1650.	9.0	630.	120.
	0311	.398	605.	572.	2.30	.35	.61	.50	.082	17.	1170.	4.0	480.	100.
770617	1922	.027	0.	0.	.00	.00	.00	.00	.000	0.	1690.	6.0	1140.	220.
	1924	.387	975.	437.	3.20	.87	2.80	.46	.002	85.	1710.	20.0	1360.	160.
	1927	1.757	825.	432.	3.00	.42	1.52	.44	.002	30.	2030.	10.0	1030	180.
	1929	1.[illegible]06	650.	334.	2.30	.28	1.10	.32	.002	20.	1190.	7.0	570.	170.
	1932	1.534	390.	270.	2.00	.19	.95	.26	.002	13.	890.	5.0	430.	90.
	1934	1.366	355.	240.	1.60	.15	.75	.26	.006	13.	580.	4.0	250.	60.
	1937	1.449	365.	209.	1.30	.16	.71	.18	.008	16.	520.	5.0	260.	60.

Table II-A-36. Flow and parameter concentrations for selected events at Noyes Creek (413011)

			Concentration (mg/l)								: Concentration (ug/l)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
770420	1900	.057	1215.	59.	1.50	.13	1.09	.16	.002	355.	115.	.2	200.	37.
	2000	.062	1360.	58.	1.20	.07	1.10	.07	.005	400.	[illegible]0.	1.7	130.	35.
	2100	.068	1040.	324.	2.40	.04	.82	.36	.002	225.	140.	2.6	260.	35.
	2245	.102	1045.	70.	1.00	.15	1.00	.14	.002	350.	65.	5.4	160.	27.
	2330	.105	1210.	51.	.90	.18	.81	.07	.002	405.	50.	2.3	110.	20.
770421	0100	.108	920.	40.	.70	.16	.88	.03	.002	275.	30.	2.0	110.	20.
	0200	.110	750.	26.	.80	.14	.96	.05	.005	220.	30.	1.7	1[illegible]0.	40.
	0330	.113	695.	14.	.70	.09	.96	.05	.002	210.	20.	.2	80.	40.
	1235	.156	355.	24.	.70	.06	.75	.08	.009	105.	30.	.3	110.	30.
	1305	.201	455.	28.	.80	.05	.71	.08	.007	125.	30.	.5	90.	17.
	1350	.173	550.	18.	.80	.13	.67	.08	.002	155.	20.	2.1	100.	25.
	1550	.102	495.	14.	.60	.04	.65	.06	.004	148.	25.	.3	60.	27.
770608	1305	.147	370.	73.	.80	.06	.91	.15	.023	62.	30.	1.0	100.	50.
	1335	.244	310.	65.	.60	.13	.87	.16	.032	54.	30.	3.0	120.	40.
	1405	.261	395.	36.	.70	.12	.87	.12	.036	84.	20.	2.0	320.	160.
	1450	.201	295.	69.	.70	.10	.63	.14	.031	50.	50.	1.0	300.	120.
	1535	.280	440.	190.	.50	.08	.59	.25	.040	42.	40.	3.0	240.	60.
	1605	.481	355.	77.	.80	.07	.58	.05	.000	62.	20.	1.0	80.	50.
	1650	.396	295.	51.	.60	.06	.46	.13	.050	50.	40.	1.0	90.	50.
	1720	.311	335.	53.	.70	.10	.45	.16	.052	58.	30.	.0	100.	40.
	2135	.187	335.	31.	.50	.07	.56	.11	.035	60.	20.	1.0	370.	190.
	2335	.125	300.	21.	.50	.05	.51	.11	.034	52.	0.	1.0	80.	50.

Table II-A-37. Flow and parameter concentrations for selected events at New Berlin (413625), Elm Grove (683090) and Donges Bay (463001)

			Concentration (mg/l)								: Concentration (ug/l)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
								New Berlin						
770813	1523	.012	465.	97.	1.10	.38	.09	.20	.032	83.	80.	5.0	20.	40.
	1543	.019	510.	376.	1.40	.46	.65	.46	.129	17.	560.	1.0	190.	50.
	1643	.093	2175.	1782.	2.60	.17	.55	.96	.081	35.	440.	1.0	420.	110.
	1743	.060	625.	486.	1.30	.11	.67	.43	.082	19.	200.	2.0	120.	40.
	1843	.037	350.	163.	.90	.08	.60	.30	.090	25.	110.	2.0	120.	40.
	1943	.020	300.	106.	.80	.10	.43	.25	.093	28.	110.	1.0	30.	30.
	2043	.008	335.	75.	.80	.07	.56	.21	.095	43.	70.	1.0	60.	30.
								Elm Grove						
770813	1440	.001	320.	34.	1.60	.17	.50	.35	.172	70.	120.	15.0	60.	30.
	1510	.004	315.	25.	1.40	.08	.74	.33	.220	68.	80.	3.0	50.	20.
	1610	.013	190.	42.	1.60	.14	.37	.44	.270	16.	110.	7.0	30.	30.
	1710	.010	200.	36.	2.00	.23	.62	.65	.440	20.	80.	4.0	50.	30.
	1810	.007	190.	22.	1.50	.23	.68	.69	.540	22.	80.	1.0	50.	20.
	1910	.005	185.	20.	1.50	.19	.65	.62	.520	16.	40.	1.0	100.	40.
	2010	.004	210.	17.	1.30	.16	.60	.56	.480	16.	90.	3.0	70.	30.
								Donges Bay						
770611	0225	.038	705.	55.	1.20	.24	2.00	.12	.043	32.	0.	.0	0.	0.
	0250	.340	6640.	6536.	18.20	1.30	2.60	5.80	.087	4.	260.	19.0	900.	220.
	0315	1.218	3685.	3436.	13.20	1.30	2.90	4.00	.115	5.	50.	11.0	550.	150.
	0350	1.557	1585.	1222.	7.20	2.80	5.00	1.80	.220	16.	20.	4.0	240.	90.
	0515	1.472	2325.	2056.	8.00	1.00	3.40	2.60	.110	11.	40.	3.0	360.	120.
	0650	1.557	1745.	1384.	5.40	.60	4.80	1.70	.097	17.	20.	2.0	240.	90.
	0850	1.019	995.	568.	4.00	.44	8.10	1.10	.230	26.	20.	3.0	170.	110.
	1605	.368	805.	73.	2.00	.11	10.80	.27	.083	38.	10.	5.0	60.	70.

Table II-A-38. Flow and parameter input rates (instantaneous load) for selected events at Brookfield Square Shopping Center (683089)

			Input rate (g/sec)								Input rate (mg/sec)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
770402	0107	.100	29.1	10.8	.080	.054	.140	.014	.0019	6.62	46.1	1.71	30.1	9.0
	0906	.012	11.2	3.5	.014	.007	.024	.002	.0001	3.25	8.3	.18	4.8	1.0
	0938	.063	16.5	9.4	.044	.041	.086	.007	.0008	2.34	24.1	.38	19.0	4.4
	1033	.040	17.7	2.5	.020	.022	.047	.002	.0006	1.75	5.6	.12	11.9	1.6
	1408	.112	218.1	202.1	.379	.070	.071	.099	.0009	4.68	326.8	2.23	103.7	15.6
	1534	.097	36.0	21.6	.097	.100	.100	.019	.0007	3.69	61.3	.68	54.5	8.8
	1817	.017	9.5	.4	.010	.007	.019	.001	.0002	3.45	2.1	.17	4.7	.5
770420	1752	.009	28.1	14.7	.033	.001	.016	.021	.0002	4.49	17.2	.27	10.1	9.2
	1956	.031	61.3	51.7	.123	.010	.059	.035	.0001	1.73	71.4	.72	34.0	7.5
	2007	.658	608.9	539.8	1.382	.165	.678	.388	.0059	8.56	1066.4	4.61	513.5	92.2
	2152	.017	5.4	.9	.015	.008	.044	.003	.0008	.61	.3	.15	7.3	.7
770421	1013	.046	7.8	1.6	.032	.012	.055	.005	.0007	.87	1.8	.27	20.1	1.4
770617	1920	.007	16.9	10.0	.010	.002	.008	.007	.0001	1.15	6.7	.05	3.3	.8
	1923	.017	16.6	12.1	.029	.016	.027	.007	.0011	.27	18.1	.09	8.0	1.2
	1931	2.078	883.2	629.7	2.702	1.060	1.891	.499	.0561	16.63	1205.3	8.31	602.7	103.9
	1943	1.252	244.1	126.5	.876	.376	.789	.138	.0113	7.51	112.7	5.01	137.7	37.6
	2012	.101	18.7	5.0	.091	.032	.102	.013	.0026	1.32	4.1	.30	10.1	2.0
770618	1305	.009	7.7	.1	.004	.001	.009	.003	.0013	1.03	.3	.01	.5	.2
770630	0724	.082	27.4	13.5	.074	.023	.074	.016	.001	2.21	31.1	.98	71.3	5.7
	0748	1.252	207.9	179.0	.501	.163	.401	.125	.0213	2.50	225.4	36.31	513.3	50.1
	0836	.121	13.3	7.6	.004	.011	.041	.008	.0025	.48	35.0	1.69	31.4	4.6
	0857	.081	15.0	11.2	.041	.006	.023	.007	.0012	.24	12.1	.41	4.9	2.4
	0908	1.010	116.2	77.8	.404	.040	.202	.061	.0243	7.07	90.9	4.04	111.2	40.4
	0943	.219	19.7	9.9	.066	.007	.046	.015	.0053	1.54	8.6	.66	59.2	6.6
	1324	.017	6.7	.3	.005	.001	.013	.002	.0014	.92	12.8	.03	17.9	1.7

Table II-A-39. Flow and parameter input rates (instantaneous load) for selected events at Stadium Interchange (413615)

			Input rate (g/sec)								Input rate (mg/sec)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
770402	0018	.031	67.5	5.0	.047	.012	.143	.006	.0002	26.43	26.1	.34	14.3	3.1
	0054	.063	63.3	19.4	.088	.035	.189	.017	.0007	17.31	95.1	.31	42.2	9.4
	0058	.167	156.7	79.7	.267	.068	.325	.060	.0013	26.66	380.0	1.50	155.0	33.3
	0112	.141	55.6	25.3	.112	.073	.203	.024	.0023	11.25	116.7	.56	53.4	15.5
	0123	.087	29.3	8.2	.044	.043	.113	.012	.0017	7.87	34.1	.18	25.4	5.2
	0133	.132	45.7	15.9	.066	.049	.140	.019	.0028	11.39	70.2	.40	38.4	10.6
	0147	.107	29.3	7.8	.043	.034	.096	.012	.0021	8.11	35.2	.21	25.6	7.5
770420	2004	.024	66.6	37.1	.132	.006	.073	.026	.0000	14.03	156.9	.44	59.3	12.0
	2007	.381	1017.1	845.7	2.781	.187	.697	.545	.0008	87.62	3568.5	7.24	1264.7	224.8
	2009	.374	855.6	668.0	2.396	.195	.659	.490	.0007	44.93	3216.4	11.61	1100.9	183.5
	2012	.320	608.1	510.8	2.080	.198	.512	.419	.0006	43.21	2377.9	3.84	883.3	160.0
	2014	.219	341.2	269.4	1.356	.129	.352	.258	.0011	25.15	942.6	2.19	481.1	70.0
	2017	.176	219.5	170.0	.917	.102	.293	.174	.0009	23.80	509.5	1.41	253.9	47.6
	2019	.135	131.4	87.8	.542	.069	.230	.100	.0003	18.28	276.3	.68	157.1	31.1
770605	0253	.033	60.6	15.7	.090	.018	.110	.013	.0003	9.16	86.6	.73	38.0	6.7
	0256	1.802	4729.8	2782.0	7.928	1.297	2.180	1.568	.0144	99.10	13441.6	23.42	4180.2	1441.5
	0259	1.609	2959.8	2490.1	6.917	.933	1.158	1.480	.0097	43.43	11147.5	32.17	3104.6	659.5
	0302	.979	1781.8	1031.9	3.622	.372	.607	.754	.0127	19.58	3602.8	8.81	1145.5	244.8
	0305	.749	748.6	519.5	1.946	.195	.494	.382	.0052	11.98	1691.9	6.74	696.2	157.2
	0308	.601	466.0	301.9	1.323	.114	.355	.223	.0060	10.22	992.2	5.41	378.8	72.2
	0311	.398	240.7	227.6	.915	.139	.243	.199	.0326	6.76	465.5	1.59	191.0	39.6
770617	1922	.027	.0	.0	.000	.000	.000	.000	.0000	.00	46.3	.16	31.2	6.0
	1924	.387	377.8	169.3	1.240	.337	1.085	.178	.0008	32.93	662.5	7.75	526.9	62.0
	1927	1.757	1449.7	759.1	5.272	.738	2.671	.773	.0035	52.72	3567.2	17.57	1809.9	316.3
	1929	1.906	1238.8	636.6	4.383	.534	2.097	.610	.0036	38.12	2268.0	13.34	1086.3	324.0
	1932	1.534	598.4	414.3	3.069	.291	1.457	.399	.0031	19.95	1365.5	7.67	659.7	138.1
	1934	1.366	484.8	327.8	2.185	.205	1.024	.355	.0082	17.75	792.1	5.46	396.1	81.9
	1937	1.449	558.0	302.9	1.884	.232	1.029	.261	.0116	23.19	753.7	7.25	376.8	87.0

Table II-A-40. Flow and parameter input rates (instantaneous load) for selected events at Noyes Creek (413011)

			Input rate (g/sec)								:	Input rate (mg/sec)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlor- ides		Lead	Cadmium	Zinc	Copper
770420	1900	.057	66.8	3.3	.085	.007	.062	.009	.0001	20.11		6.5	.01	11.3	2.1
	2000	.062	84.7	3.6	.075	.004	.069	.004	.0003	24.92		2.5	.11	8.1	2.2
	2100	.068	70.7	22.0	.163	.003	.056	.025	.0001	15.29		9.5	.18	17.7	2.4
	2245	.102	106.5	7.1	.102	.019	.102	.014	.0002	35.68		6.6	.55	16.3	2.8
	2330	.105	126.8	5.3	.094	.019	.085	.007	.0002	42.43		5.2	.24	11.5	2.1
770421	0100	.108	99.0	4.3	.075	.017	.093	.003	.0002	29.59		3.2	.22	11.8	2.2
	0200	.111	82.8	2.9	.088	.015	.106	.006	.0006	24.30		3.3	.19	16.6	4.4
	0330	.113	78.7	1.6	.079	.010	.109	.006	.0002	23.79		2.3	.02	9.1	4.5
	1235	.156	55.3	3.7	.109	.009	.117	.012	.0014	16.35		4.7	.04	17.1	4.7
	1305	.201	91.5	5.6	.161	.010	.143	.016	.0014	25.13		6.0	.11	18.1	3.4
	1350	.173	95.0	3.1	.138	.022	.116	.014	.0003	26.77		3.5	.36	17.3	4.3
	1550	.102	50.5	1.4	.061	.004	.066	.006	.0004	15.09		2.5	.03	6.1	2.8
770608	1305	.147	54.5	10.7	.118	.009	.134	.022	.0034	9.13		4.4	.15	14.7	7.4
	1335	.244	75.5	15.8	.195	.032	.212	.039	.0078	13.15		7.3	.73	29.2	9.7
	1405	.261	102.9	9.4	.182	.031	.227	.031	.0094	21.88		5.2	.52	83.4	41.7
	1450	.201	59.3	13.9	.141	.020	.127	.028	.0062	10.05		10.1	.20	60.3	24.1
	1535	.280	123.3	53.3	.252	.022	.165	.070	.0112	11.77		11.2	.84	67.3	16.8
	1605	.481	170.9	37.1	.385	.034	.279	.024	.0000	29.85		9.6	.48	38.5	24.1
	1650	.396	116.9	20.2	.236	.024	.182	.052	.0198	19.82		15.9	.40	35.7	19.8
	1720	.311	104.3	16.5	.218	.031	.140	.050	.0162	18.07		9.3	.00	31.1	12.5
	2135	.187	62.6	5.8	.093	.013	.105	.021	.0065	11.21		3.7	.19	69.2	35.5
	2335	.125	37.4	2.6	.062	.006	.064	.014	.0042	6.48		.0	.12	10.0	6.2

Table II-A-41. Flow and parameter input rates (instantaneous load) for selected events at New Berlin (413625), Elm Grove (683090) and Donges Bay (463001)

			Input rate (g/sec)								: Input rate (mg/sec)			
Date	Time	Flow (cms)	Total Solids	Susp. Solids	Total Org N	NH3-N	NO2 + NO3-N	Total Phos.	Sol. Phos.	Chlorides	Lead	Cadmium	Zinc	Copper
							New Berlin							
770813	1523	.012	5.4	1.1	.013	.004	.001	.002	.0004	.97	.9	.06	.2	.5
	1543	.019	9.6	7.1	.026	.009	.012	.009	.0024	.32	10.6	.02	3.6	.9
	1643	.093	201.4	165.0	.241	.016	.051	.089	.0075	3.24	40.7	.09	38.9	10.2
	1743	.060	37.6	29.2	.078	.007	.040	.026	.0049	1.14	12.0	.12	7.2	2.4
	1843	.037	13.1	6.1	.034	.003	.022	.011	.0034	.93	4.1	.07	4.5	1.5
	1943	.020	5.9	2.1	.016	.002	.008	.005	.0018	.55	2.1	.02	.6	.6
	2043	.008	2.6	.6	.006	.001	.004	.002	.0007	.34	.5	.01	.5	.2
							Elm Grove							
770813	1440	.001	.2	.0	.001	.000	.000	.000	.0001	.04	.1	.01	.0	.0
	1510	.004	1.2	.1	.005	.000	.003	.001	.0008	.25	.3	.01	.2	.1
	1610	.013	2.5	.5	.021	.002	.005	.006	.0035	.21	1.4	.09	.4	.4
	1710	.010	2.1	.4	.021	.002	.006	.007	.0045	.21	.8	.04	.5	.3
	1810	.007	1.4	.2	.011	.002	.005	.005	.0040	.16	.6	.01	.4	.1
	1910	.005	1.0	.1	.008	.001	.003	.003	.0028	.09	.2	.01	.5	.2
	2010	.004	.8	.1	.005	.001	.002	.002	.0019	.06	.4	.01	.3	.1
							Donges Bay							
770611	0225	.034	24.0	1.9	.041	.008	.068	.004	.0015	1.09	.0	.00	.0	.0
	0250	.340	2256.3	2221.0	6.184	.442	.884	1.971	.0296	1.36	88.3	6.46	305.8	74.8
	0315	1.218	4487.0	4183.8	16.073	1.583	3.531	4.871	.1400	6.09	60.9	13.39	669.7	182.6
	0350	1.557	2468.5	1903.2	11.214	4.361	7.787	2.803	.3426	24.92	31.1	6.23	373.8	140.2
	0515	1.472	3423.5	3027.4	11.760	1.472	5.006	3.829	.1620	16.20	58.9	4.42	530.1	176.7
	0650	1.557	2717.7	2155.5	8.410	.935	7.476	2.648	.1511	26.48	31.1	3.11	373.8	140.2
	0850	1.019	1014.3	579.0	4.078	.448	8.257	1.121	.2345	26.50	20.4	3.06	173.3	112.1
	1605	.368	296.3	26.9	.736	.041	3.976	.099	.0306	13.99	3.7	1.84	22.1	25.8

Table II-A-42. Seasonal loadings of water at the predominantly single land use monitoring sites

STORET number	Load, m^3/ha				
	Spring	Summer	Fall	Winter	Total
			1976		
413616	+	759	29	0.0	788
413615	+	127	14	92	233
683089	i.d.	357	90	0.0	447
413011	3,253	235	91	0.0	3,579
413010	607	145	46	0.0	798
413614	i.d.	139	18	25	182
413625	+	1.1	2.8	i.d.	3.9
683090	i.d.	0.0	0.0	0.0	0.0
463001	1,745	24	0.0	0.0	1,769
			1977		
413616	509	3,282	230	0.0	4,021
413615	443	1,593	237	100	2,373
683089	683	1,246	103	0.0	2,033
413011	342	1,145	i.d.	0.0	1,487
413010	229	647	62	0.0	938
413034	22	241	68	0.0	331
413614	142	457	241	0.0	840
413625	96	32	9.4	0.0	138
683090	39	38	30	0.0	106
463001	i.d.	132	67	0.0	199

+ Station not operational.
i.d. Data insufficient for loading determination.

Table II-A-43. Seasonal loadings (with 95% confidence interval)+ of total solids at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		617.679 (83.123)	814.002	19.611 (1.557)	668.570	0.0		637.290 (83.128)	808.590
413615	++		50.549 (58.557)	398.168	8.713 (54.113)	636.346	237.461 (59.976)	2578.791	296.723 (71.453)	1274.977
683089	i.d.		127.564 (76.420)	356.873	20.829 (20.701)	231.529	0.0		146.390 (78.646)	321.672
413011	3268.380 (838.461)	1004.728	110.678 (16.121)	470.970	18.973 (2.547)	208.495	0.0		3398.031 (838.612)	949.436
413010	417.623 (105.750)	688.012	112.666 (137.143)	777.007	6.002 (3.328)	130.478	0.0		536.291 (170.309)	672.044
413614	i.d.		104.679 (17.438)	754.317	5.354 (1.066)	294.526	22.770 (1.997)	921.363	132.803 (17.546)	731.035
413625	++		.333 (.245)	296.925	.227 (.077)	82.500	i.d.		.560 (.242)	144.474
683090	i.d.		0.0		0.0		0.0		0.0	
463001	1074.788 (131.878)	615.924	20.538 (12.516)	855.750	0.0		0.0		1095.326 (132.264)	619.178
					1977					
413616	309.616 (52.163)	608.762	3708.724 (812.073)	1129.952	i.d.		0.0		4018.340 (813.576)	1060.026
413615	510.357 (161.323)	1151.719	1117.209 (523.157)	701.151	i.d.		i.d.		1627.565 (545.870)	799.190
683089	480.847 (317.929)	703.617	343.134 (124.778)	275.261	i.d.		0.0		823.981 (338.030)	426.939
413011	267.692 (34.681)	782.725	1437.518 (1484.899)	1255.474	i.d.		0.0		1705.209 (1485.312)	1146.744
413010	206.839 (300.370)	903.227	562.037 (416.122)	868.682	i.d.		0.0		768.876 (481.333)	877.712
413034	15.868 (40.495)	734.589	90.386 (43.251)	375.148	i.d.		0.0		106.254 (44.347)	404.724
413614	51.394 (13.282)	360.800	163.356 (34.937)	357.408	i.d.		0.0		214.750 (36.694)	358.214
413625	41.533 (30.590)	430.346	20.692 (7.748)	648.518	i.d.		0.0		62.225 (29.255)	484.552
683090	14.259 (1.071)	368.983	2.024 (.104)	53.173	i.d.		0.0		16.283 (1.074)	212.276
463001	i.d.		237.805 (141.816)	1801.553	i.d.		0.0		237.805 (141.816)	1801.553

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-44. Seasonal loadings (with 95% confidence interval)$^{+}$ of suspended solids at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		202.163 (79.251)	266.419	4.258 (3.489)	145.159	0.0		206.421 (79.269)	261.906
413615	++		10.465 (7.678)	82.432	4.164 (6.178)	304.099	36.231 (16.747)	393.464	50.860 (17.134)	218.538
683089	i.d.		78.240 (53.376)	218.883	6.023 (5.894)	66.959	0.0		84.263 (53.569)	188.339
413011	1422.740 (792.427)	437.362	50.769 (22.826)	216.038	3.262 (2.359)	35.846	0.0		1476.770 (792.742)	412.621
413010	142.441 (54.781)	234.664	83.458 (112.980)	575.572	3.868 (9.225)	84.087	0.0		229.766 (124.650)	287.927
413614	i.d.		64.322 (9.648)	463.509	1.187 (.233)	65.291	.958 (.225)	38.774	66.467 (9.651)	365.881
413625	++		.237 (.179)	211.402	.044 (.031)	16.000	i.d.		.281 (.178)	72.476
683090	i.d.		0.0		0.0		0.0		0.0	
463001	274.831 (112.936)	157.496	8.432 (13.915)	351.333	0.0		0.0		283.263 (113.219)	160.126
					1977					
413616	80.925 (30.564)	159.113	1627.842 (596.247)	495.961	2.821 (2.561)	12.271	0.0		1711.588 (596.869)	425.696
413615	230.042 (75.568)	519.133	694.853 (271.856)	436.084	51.042 (26.066)	215.134	13.699 (4.803)	137.543	989.636 (283.498)	416.974
683089	349.662 (348.479)	511.655	187.543 (82.151)	150.446	3.548 (1.469)	34.328	0.0		540.752 (356.556)	265.946
413011	49.246 (18.971)	143.994	779.681 (744.236)	680.944	i.d.		0.0		828.926 (744.463)	557.449
413010	169.015 (281.472)	738.057	264.889 (123.628)	409.411	9.119 (125.510)	147.081	0.0		443.023 (291.100)	472.306
413034	10.179 (12.042)	471.205	48.090 (25.509)	199.598	27.002 (5.486)	396.091	0.0		85.271 (26.227)	257.844
413614	15.906 (11.287)	111.666	71.981 (27.615)	157.487	7.143 (4.545)	29.657	0.0		95.030 (29.094)	113.082
413625	6.546 (1.971)	67.829	11.241 (4.777)	352.298	.975 (.270)	103.802	0.0		18.761 (4.885)	136.143
683090	.943 (.220)	24.395	1.071 (.667)	28.138	1.042 (.066)	35.068	0.0		3.056 (.686)	28.714
463001	i.d.		114.996 (101.727)	871.182	12.640 (3.485)	188.657	0.0		127.636 (101.760)	641.387

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-45. Seasonal loadings (with 95% confidence interval)+ of volatile suspended solids at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		50.534 (13.665)	66.596	1.219 (1.820)	41.542	0.0		51.753 (13.675)	65.663
413615	++		4.144 (3.159)	32.642	1.199 (1.680)	87.544	9.114 (3.908)	98.980	14.457 (4.332)	62.119
683089	i.d.		12.560 (9.228)	35.139	1.984 (1.681)	22.057	0.0		14.545 (9.327)	32.510
413011	113.356 (54.101)	34.847	5.620 (1.363)	23.915	.681 (.164)	7.484	0.0		119.657 (54.118)	33.433
413010	40.356 (17.228)	66.484	13.539 (15.146)	93.372	1.431 (3.344)	31.109	0.0		55.326 (22.667)	69.331
413614	i.d.		9.573 (1.461)	68.981	.381 (.080)	20.944	.245 (.048)	9.933	10.199 (1.463)	56.141
413625	++		.027 (.014)	24.006	.019 (.031)	7.000	i.d.		.046 (.013)	11.915
683090	i.d.		0.0		0.0		0.0		0.0	
463001	45.013 (20.083)	25.795	1.427 (2.275)	59.458	0.0		0.0		46.440 (20.118)	26.252
					1977					
413616	18.311 (6.012)	36.003	344.082 (110.018)	104.833	i.d.		0.0		362.393 (110.150)	95.598
413615	47.275 (13.645)	106.685	119.185 (37.982)	74.800	i.d.		i.d.		166.460 (40.221)	81.738
683089	42.173 (35.407)	61.711	24.883 (8.727)	19.961	i.d.		0.0		67.056 (36.289)	34.745
413011	6.676 (2.019)	19.520	62.428 (51.515)	54.522	i.d.		0.0		69.104 (51.553)	46.472
413010	52.377 (80.261)	228.721	48.985 (23.508)	75.711	i.d.		0.0		101.361 (80.251)	115.709
413034	1.770 (5.568)	81.961	7.862 (4.140)	32.632	i.d.		0.0		9.633 (4.288)	36.691
413614	3.571 (2.297)	25.069	10.459 (3.836)	22.884	i.d.		0.0		14.030 (4.332)	23.403
413625	1.648 (.783)	17.076	1.454 (.622)	45.559	i.d.		0.0		3.102 (.817)	24.153
683090	.204 (.110)	5.279	.088 (.015)	2.318	i.d.		0.0		.292 (.110)	3.810
463001	i.d.		20.222 (13.383)	153.197	i.d.		0.0		20.222 (13.383)	153.197

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-46. Seasonal loadings (with 95% confidence interval)+ of total phosphorus at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
1976										
413616	++		1.041 (.205)	1.371	.032 (.013)	1.079	0.0		1.072 (.205)	1.360
413615	++		.022 (.009)	.173	.013 (.063)	.935	.076 (.012)	.827	.111 (.020)	.477
683089	i.d.		.095 (.051)	.267	.024 (.031)	.267	0.0		.419 (.057)	.266
413011	1.287 (.446)	.396	.069 (.017)	.294	.015 (.008)	.165	0.0		1.370 (.447)	.383
413010	.276 (.076)	.455	.122 (.168)	.841	.017 (.022)	.370	0.0		.415 (.183)	.520
413614	i.d.		.099 (.025)	.713	.008 (.002)	.467	.007 (.000)	.288	.115 (.025)	.631
413625	++		.001 (.000)	.481	.001 (.001)	.295	i.d.		.001 (.000)	.349
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.633 (.170)	.363	.014 (.014)	.583	0.0		0.0		.647 (.170)	.366
1977										
413616	.454 (.085)	.892	3.712 (.863)	1.131	.129 (.087)	.561	0.0		4.295 (.866)	1.068
413615	.239 (.070)	.538	.629 (.169)	.395	.060 (.039)	.254	.012 (.016)	.120	.946 (.191)	.399
683089	.263 (.217)	.384	.216 (.159)	.174	.007 (.003)	.067	0.0		.486 (.264)	.239
413011	.075 (.017)	.219	.614 (.362)	.536	i.d.		0.0		.689 (.362)	.463
413010	.243 (.376)	1.061	.352 (.087)	.544	.022 (.105)	.355	0.0		.617 (.378)	.658
413034	.016 (.012)	.742	.042 (.012)	.175	.072 (.011)	1.058	0.0		.130 (.018)	.394
413614	.030 (.018)	.207	.084 (.027)	.185	.051 (.027)	.210	0.0		.165 (.034)	.196
413625	.039 (.042)	.407	.012 (.002)	.386	.002 (.000)	.217	0.0		.054 (.042)	.389
683090	.008 (.001)	.213	.017 (.001)	.437	.009 (.008)	.295	0.0		.034 (.007)	.316
463001	i.d.		.174 (.099)	1.318	.025 (.010)	.373	0.0		.200 (.099)	1.005

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-47. Seasonal loadings (with 95% confidence interval)* of soluble phosphorus at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
1976										
413616	++		.277 (.010)	.364	.007 (.001)	.232	0.0		.283 (.010)	.359
413615	++		.003 (.001)	.022	.000 (.002)	.023	.022 (.005)	.243	.025 (.005)	.109
683089	i.d.		.010 (.007)	.029	.002 (.000)	.022	0.0		.012 (.007)	.027
413011	.188 (.77)	.058	.007 (.001)	.030	.006 (.004)	.066	0.0		.201 (.078)	.056
413010	.066 (.023)	.109	.013 (.025)	.090	.004 (.003)	.087	0.0		.083 (.033)	.104
413614	i.d.		.007 (.002)	.048	.001 (.000)	.080	.003 (.001)	.120	.011 (.002)	.061
413625	++		.000 (.000)	.104	.000 (.001)	.150	i.d.		.001 (.000)	.137
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.178 (.029)	.102	.002 (.002)	.083	0.0		0.0		.179 (.029)	.101
1977										
413616	.137 (.020)	.270	.847 (.272)	.258	i.d.		0.0		.985 (.272)	.260
413615	.010 (.009)	.024	.026 (.019)	.016	i.d.		i.d.		.036 (.021)	.018
683089	.007 (.002)	.010	.017 (.007)	.013	i.d.		0.0		.023 (.008)	.012
413011	.008 (.002)	.023	.062 (.029)	.054	i.d.		0.0		.070 (.029)	.047
413010	.010 (.005)	.044	.037 (.009)	.057	i.d.		0.0		.047 (.010)	.054
413034	.001 (.001)	.034	.004 (.003)	.015	i.d.		0.0		.004 (.003)	.016
413614	.002 (.001)	.016	.009 (.003)	.019	i.d.		0.0		.011 (.003)	.019
413625	.022 (.031)	.226	.003 (.000)	.089	i.d.		0.0		.025 (.031)	.192
683090	.004 (.001)	.113	.003 (.000)	.088	i.d.		0.0		.008 (.001)	.101
463001	i.d.		.023 (.009)	.174	i.d.		0.0		.023 (.009)	.174

* ( ) 95% Confidence interval

++ Station not operational

i.d. Data insufficient for loading determination

Table II-A-48. Seasonal loadings (with 95% confidence interval)+ of total organic nitrogen at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
					1976					
413616	++		1.240 (.207)	1.634	.044 (.124)	1.487	0.0		1.283 (.208)	1.628
413615	++		.271 (.100)	2.137	.064 (.035)	4.644	.334 (.039)	3.623	.669 (.094)	2.872
683089	i.d.		.532 (.285)	1.488	.121 (.106)	1.345	0.0		.654 (.301)	1.462
413011	3.439 (1.028)	1.057	.300 (.031)	1.277	.063 (.019)	.692	0.0		3.801 (1.029)	1.062
413010	.920 (.284)	1.516	.554 (.851)	3.821	.079 (.074)	1.717	0.0		1.554 (.883)	1.947
413614	i.d.		.353 (.066)	2.545	.031 (.022)	1.704	.058 (.007)	2.344	.442 (.067)	2.434
413625	++		.002 (.002)	1.723	.002 (.002)	.875	i.d.		.004 (.002)	1.120
683090	i.d.		0.0		0.0		0.0		0.0	
463001	2.558 (.290)	1.466	.063 (.054)	2.625	0.0		0.0		2.621 (.292)	1.482
					1977					
413616	.529 (.122)	1.040	6.183 (1.396)	1.884	i.d.		0.0		6.712 (1.401)	1.771
413615	1.244 (.378)	2.808	3.531 (.928)	2.216	i.d.		i.d.		4.775 (.997)	2.345
683089	1.186 (.817)	1.736	1.095 (.238)	.878	i.d.		0.0		2.281 (.845)	1.182
413011	.377 (.049)	1.102	1.816 (.825)	1.586	i.d.		0.0		2.193 (.826)	1.475
413010	1.157 (1.945)	5.052	1.708 (.487)	2.640	i.d.		0.0		2.865 (1.964)	3.271
413034	.060 (.118)	2.767	.291 (.110)	1.207	i.d.		0.0		.351 (.112)	1.335
413614	.182 (.079)	1.276	.448 (.105)	.981	i.d.		0.0		.630 (.126)	1.051
413625	.153 (.112)	1.584	.044 (.010)	1.378	i.d.		0.0		.197 (.110)	1.533
683090	.045 (.004)	1.157	.015 (.001)	.402	i.d.		0.0		.060 (.005)	.782
463001	i.d.		.609 (.347)	4.614	i.d.		0.0		.609 (.347)	4.614

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-49. Seasonal loadings (with 95% confidence interval)$^{+}$ of ammonia nitrogen at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.072 (.023)	.095	.001 (.013)	.039	0.0		.074 (.023)	.093
413615	++		.066 (.017)	.521	.018 (.044)	1.285	.114 (.016)	1.240	.198 (.022)	.851
683089	i.d.		.107 (.045)	.299	.025 (.046)	.278	0.0		.132 (.060)	.295
413011	.860 (.204)	.264	.037 (.008)	.157	.009 (.010)	.099	0.0		.907 (.204)	.253
413010	.227 (.056)	.374	.036 (.044)	.248	.008 (.025)	.174	0.0		.271 (.071)	.340
413614	i.d.		.040 (.010)	.291	.010 (.012)	.537	.016 (.003)	.642	.066 (.011)	.364
413625	++		.000 (.000)	.049	.000 (.000)	.075	i.d.		.000 (.000)	.067
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.360 (.055)	.206	.004 (.003)	.167	0.0		0.0		.364 (.055)	.206
					1977					
413616	.054 (.033)	.106	.215 (.064)	.065	i.d.		0.0		.268 (.071)	.071
413615	.213 (.051)	.481	.518 (.141)	.325	i.d.		i.d.		.731 (.150)	.359
683089	.215 (.182)	.315	.301 (.107)	.242	i.d.		0.0		.516 (.208)	.268
413011	.066 (.018)	.193	.276 (.210)	.241	i.d.		0.0		.342 (.211)	.230
413010	.040 (.026)	.175	.093 (.054)	.144	i.d.		0.0		.133 (.057)	.152
413034	.009 (.016)	.418	.047 (.020)	.195	i.d.		0.0		.056 (.020)	.214
413614	.030 (.010)	.214	.029 (.011)	.064	i.d.		0.0		.059 (.014)	.099
413625	.016 (.020)	.169	.005 (.002)	.145	i.d.		0.0		.021 (.020)	.163
683090	.003 (.002)	.088	.002 (.000)	.041	i.d.		0.0		.005 (.002)	.065
463001	i.d.		.078 (.099)	.591	i.d.		0.0		.078 (.099)	.591

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-50. Seasonal loadings (with 95% confidence interval)* of (nitrate + nitrite) - nitrogen at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
					1976					
413616	**		.604 (.206)	.796	.017 (.064)	.594	0.0		.621 (.206)	.789
413615	**		.327 (.219)	2.577	.058 (.203)	4.240	.168 (.020)	1.825	.553 (.212)	2.378
683089	i.d.		.331 (.130)	.927	.106 (.053)	1.178	0.0		.436 (.145)	.979
413011	2.181 (.272)	.670	.208 (.047)	.885	.037 (.003)	.407	0.0		2.427 (.276)	.678
413010	.486 (.122)	.801	.087 (.068)	.600	.036 (.033)	.783	0.0		.609 (.139)	.763
413614	i.d.		.170 (.032)	1.227	.034 (.067)	1.878	.027 (.002)	1.100	.232 (.036)	1.275
413625	**		.001 (.000)	.670	.002 (.001)	.560	i.d.		.002 (.000)	.592
683090	i.d.		0.0		0.0		0.0		0.0	
463001	7.972 (.831)	4.568	.060 (.088)	2.500	0.0		0.0		8.032 (.834)	4.540
					1977					
413616	.300 (.075)	.590	1.498 (.678)	.455	i.d.		0.0		1.798 (.682)	.473
413615	.706 (.178)	1.593	1.508 (.566)	.946	i.d.		i.d.		2.214 (.591)	1.087
683089	.696 (.492)	1.018	.796 (.169)	.639	i.d.		0.0		1.492 (.516)	.773
413011	.355 (.049)	1.038	.765 (.233)	.664	i.d.		0.0		1.115 (.238)	.750
413010	.140 (.076)	.611	.388 (.085)	.609	i.d.		0.0		.535 (.110)	.611
413034	.047 (.070)	2.160	.193 (.073)	.802	i.d.		0.0		.240 (.075)	.914
413614	.089 (.039)	.627	.326 (.061)	.720	i.d.		0.0		.418 (.068)	.698
413625	.071 (.044)	.740	.019 (.004)	.594	i.d.		0.0		.090 (.043)	.704
683090	.032 (.005)	.840	.005 (.001)	.135	i.d.		0.0		.038 (.005)	.490
463001	i.d.		.446 (.218)	3.379	i.d.		0.0		.446 (.218)	3.379

* ( ) 95% Confidence interval
** Station not operational
i.d. Data insufficient for loading determination

Table II-A-51. Seasonal loadings (with 95% confidence interval)⁺ of total organic carbon at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		27.292 (15.371)	35.966	.674 (1.563)	22.968	0.0		27.965 (15.374)	35.482
413615	++		3.771 (2.388)	29.703	1.143 (5.877)	83.512	8.220 (1.992)	89.272	13.135 (2.280)	56.438
683089	i.d.		8.229 (4.916)	23.021	1.833 (1.728)	20.378	0.0		10.061 (5.244)	22.488
413011	40.609 (12.177)	12.484	3.198 (.393)	13.609	.638 (1.119)	7.011	0.0		44.445 (12.195)	12.418
413010	18.040 (8.322)	29.720	5.660 (9.816)	39.034	.560 (.481)	12.174	0.0		24.260 (12.496)	30.401
413614	i.d.		3.414 (1.009)	24.603	.334 (.464)	18.356	.741 (.057)	29.996	4.489 (1.020)	24.711
413625	++		.013 (.010)	11.216	.023 (.008)	8.250	i.d.		.035 (.009)	9.107
683090	i.d.		0.0		0.0		0.0		0.0	
463001	25.453 (4.053)	14.586	.376 (.185)	15.667	0.0		0.0		25.829 (4.056)	14.601
					1977					
413616	17.038 (18.704)	33.499	163.313 (69.827)	49.757	i.d.		0.0		180.351 (70.405)	47.576
413615	23.874 (7.768)	53.877	47.773 (17.737)	29.982	i.d.		i.d.		71.648 (18.988)	35.181
683089	24.476 (18.520)	35.816	19.600 (7.120)	15.723	i.d.		0.0		44.076 (19.394)	22.838
413011	3.661 (.680)	10.705	19.760 (17.564)	17.258	i.d.		0.0		23.421 (17.577)	15.751
413010	17.728 (116.747)	77.415	18.858 (14.307)	29.147	i.d.		0.0		36.586 (119.177)	41.765
413034	.453 (.124)	20.983	4.205 (1.602)	17.455	i.d.		0.0		4.659 (1.604)	17.745
413614	3.598 (5.759)	25.262	5.586 (.830)	12.221	i.d.		0.0		9.184 (5.193)	15.319
413625	1.258 (.192)	13.032	.611 (.310)	19.150	i.d.		0.0		1.869 (.300)	14.552
683090	.557 (.060)	14.412	.127 (.024)	3.329	i.d.		0.0		.684 (.061)	8.913
463001	i.d.		4.194 (4.428)	31.773	i.d.		0.0		4.196 (4.428)	31.788

⁺ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-52. Seasonal loadings (with 95% confidence interval)$^{+}$ of chloride at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		28.124 (1.545)	37.062	.930 (1.339)	31.709	0.0		29.054 (1.556)	36.863
413615	++		7.118 (12.727)	56.065	.628 (11.109)	45.889	108.120 (35.143)	1174.161	115.866 (35.851)	497.858
683089	i.d.		5.438 (9.240)	15.213	.743 (6.181)	8.260	0.0		6.181 (9.314)	13.815
413011	662.846 (250.788)	203.765	10.182 (2.921)	43.328	1.438 (2.161)	15.802	0.0		674.466 (250.809)	188.451
413010	144.185 (69.213)	237.537	1.031 (1.445)	7.110	.237 (.213)	5.152	0.0		145.452 (69.228)	182.271
413614	i.d.		6.120 (4.113)	44.100	.594 (.259)	32.691	10.572 (1.156)	427.778	17.286 (4.244)	95.155
413625	++		.003 (.008)	2.952	.002 (.008)	.750	i.d.		.005 (.007)	1.386
683090	i.d.		0.0		0.0		0.0		0.0	
463001	66.742 (9.052)	38.248	.782 (.261)	32.583	0.0		0.0		67.525 (9.054)	38.171
					1977					
413616	36.535 (7.707)	71.835	123.511 (12.946)	37.631	i.d.		0.0		160.046 (14.876)	42.220
413615	120.335 (87.874)	271.559	42.643 (30.453)	26.762	i.d.		i.d.		162.978 (92.627)	80.028
683089	34.038 (39.598)	49.807	12.194 (6.213)	9.782	i.d.		0.0		46.232 (39.998)	23.955
413011	64.400 (16.047)	188.304	36.868 (11.933)	32.199	i.d.		0.0		101.268 (19.659)	68.102
413010	14.554 (10.028)	63.555	9.319 (6.020)	14.403	i.d.		0.0		23.874 (10.761)	27.253
413034	1.275 (5.767)	59.019	3.196 (1.076)	13.266	i.d.		0.0		4.471 (4.488)	17.031
413614	5.393 (3.208)	37.863	13.219 (6.616)	28.922	i.d.		0.0		18.613 (7.077)	31.047
413625	8.207 (9.946)	85.039	.875 (.265)	27.439	i.d.		0.0		9.083 (9.936)	70.728
683090	3.294 (.476)	85.230	.215 (.050)	5.654	i.d.		0.0		3.509 (.477)	45.744
463001	i.d.		2.679 (1.051)	20.295	i.d.		0.0		2.679 (1.051)	20.295

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-53. Seasonal loadings (with 95% confidence interval)+ of iron at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		8.424 (2.586)	11.101	.305 (.330)	10.406	0.0		8.729 (2.588)	11.076
413615	++		.424 (.201)	3.337	.116 (.097)	8.470	.918 (.369)	9.971	1.458 (.392)	6.264
683089	i.d.		1.636 (1.130)	4.577	.148 (.150)	1.645	0.0		1.784 (1.134)	3.987
413011	10.192 (8.467)	3.133	i.d.		i.d.		0.0		10.192 (8.467)	3.133
413010	2.560 (1.009)	4.217	6.851 (65.165)	47.248	i.d.		0.0		9.411 (65.290)	12.515
413614	i.d.		1.248 (.258)	8.993	.041 (.007)	2.274	.030 (.008)	1.212	1.319 (.259)	7.262
413625	++		.007 (.003)	6.060	.002 (.006)	.800	.051 (.012)	7.692	.060 (.004)	5.701
683090	i.d.		0.0		0.0		0.0		0.0	
463001	27.611 (25.189)	15.823	.068 (.055)	2.833	0.0		0.0		27.679 (25.189)	15.647
					1977					
413616	5.977 (2.946)	11.752	146.041 (77.643)	44.495	.811 (.240)	3.528	0.0		152.829 (77.684)	38.011
413615	6.308 (1.962)	14.235	42.471 (46.157)	26.655	2.228 (.829)	9.390	.671 (.125)	6.737	51.678 (46.201)	21.774
683089	6.227 (5.262)	9.112	5.901 (1.914)	4.734	.355 (.152)	3.434	0.0		12.483 (5.556)	6.139
413011	2.383 (.857)	6.968	25.213 (21.173)	22.020	i.d.		0.0		27.597 (21.190)	18.559
413010	5.600 (4.973)	24.454	7.134 (2.347)	11.026	.322 (2.948)	5.194	0.0		13.056 (5.130)	13.919
413034	.266 (.597)	12.308	1.634 (.594)	6.782	1.133 (.065)	16.620	0.0		3.033 (.615)	9.171
413614	.437 (.174)	3.065	2.882 (1.131)	6.306	1.853 (1.290)	7.695	0.0		5.172 (1.304)	6.154
413625	.273 (.145)	2.827	.526 (.226)	16.476	.039 (.014)	4.206	0.0		.838 (.244)	6.081
683090	.064 (.013)	1.651	.173 (.037)	4.547	.134 (.073)	4.514	0.0		.371 (.069)	3.486
463001	i.d.		3.958 (5.676)	29.985	.235 (.101)	3.507	0.0		4.194 (5.677)	21.075

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-54. Seasonal loadings (with 95% confidence interval)+ of aluminum at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
					1976					
413616	++		1.442 (.689)	1.900	.036 (.176)	1.242	0.0		1.478 (.689)	1.876
413615	++		.259 (.088)	2.038	.043 (.012)	3.149	.408 (.170)	4.435	.710 (.180)	3.051
683089	i.d.		.286 (.135)	.802	.068 (.059)	.756	0.0		.354 (.146)	.791
413011	.343 (.397)	.105	i.d.		i.d.		0.0		.343 (.397)	.105
413010	.055 (.000)	.091	.465 (.914)	3.207	i.d.		0.0		.520 (.914)	.691
413614	i.d.		.288 (.150)	2.074	.026 (.005)	1.422	.019 (.005)	.775	.333 (.150)	1.832
413625	++		.003 (.002)	2.725	.001 (.004)	.325	.031 (.011)	4.708	.035 (.005)	3.340
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.089 (.038)	.051	.016 (.014)	.667	0.0		0.0		.105 (.039)	.059
					1977					
413616	1.000 (.397)	1.967	17.328 (5.869)	5.279	.069 (.000)	.300	0.0		18.397 (5.879)	4.576
413615	2.917 (.935)	6.583	9.714 (3.654)	6.096	1.742 (1.853)	7.342	.531 (.904)	5.331	14.904 (4.662)	6.280
683089	4.481 (4.170)	6.558	2.576 (.802)	2.067	.057 (.038)	.548	0.0		7.114 (4.235)	3.499
413011	1.080 (.326)	3.158	16.010 (10.339)	13.983	i.d.		0.0		17.090 (10.344)	11.493
413010	2.168 (1.939)	9.467	4.422 (1.511)	6.835	.169 (3.233)	2.726	0.0		6.758 (2.285)	7.205
413034	.097 (.037)	4.482	.920 (.369)	3.816	.686 (.392)	10.056	0.0		1.702 (.479)	5.146
413614	.337 (.123)	2.365	1.410 (.446)	3.085	.107 (.117)	.446	0.0		1.854 (.455)	2.206
413625	.223 (.129)	2.312	.346 (.122)	10.852	.020 (.004)	2.134	0.0		.589 (.149)	4.277
683090	.052 (.010)	1.357	.142 (.085)	3.731	.026 (.007)	.880	0.0		.221 (.085)	2.073
463001	i.d.		2.481 (3.220)	18.795	.142 (.080)	2.119	0.0		2.623 (3.221)	13.181

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-55. Seasonal loadings (with 95% confidence interval)$^{+}$ of silica at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
					1976					
413616	++		8.986 (1.683)	11.842	.294 (.046)	10.023	0.0		9.280 (1.683)	11.774
413615	++		.751 (.524)	5.912	.061 (.076)	4.482	.611 (.049)	6.635	1.423 (.515)	6.114
683089	i.d.		.531 (.428)	1.486	.234 (.247)	2.601	0.0		.765 (.475)	1.710
413011	16.247 (16.992)	4.994	i.d.		i.d.		0.0		16.247 (16.992)	4.994
413010	3.219 (.002)	5.303	.696 (9.135)	4.800	i.d.		0.0		3.915 (9.135)	5.206
413614	i.d.		.533 (.115)	3.841	.068 (.022)	3.739	.132 (.015)	5.321	.733 (.117)	4.033
413625	++		i.d.		.003 (.005)	.950	.032 (.003)	4.830	.034 (.002)	3.685
683090	i.d.		0.0		0.0		0.0		0.0	
463001	15.149 (1.073)	8.681	.287 (.019)	11.958	0.0		0.0		15.436 (1.073)	8.726
					1977					
413616	3.854 (.304)	7.579	25.992 (3.239)	7.919	1.458 (.128)	6.342	0.0		31.304 (3.254)	7.786
413615	1.287 (.288)	2.905	2.736 (.916)	1.717	.432 (.264)	1.820	.165 (.130)	1.657	4.619 (1.029)	1.946
683089	1.056 (.513)	1.545	1.220 (.400)	.979	.078 (.043)	.756	0.0		2.354 (.640)	1.158
413011	1.611 (.147)	4.711	3.699 (.732)	3.231	i.d.		0.0		5.310 (.747)	3.571
413010	.897 (.197)	3.917	1.492 (.431)	2.306	.268 (1.426)	4.323	0.0		2.657 (.527)	2.833
413034	.044 (.113)	2.017	.302 (.126)	1.255	.581 (.528)	8.518	0.0		.927 (.518)	2.802
413614	.918 (.091)	6.445	1.299 (.206)	2.842	1.465 (.651)	6.080	0.0		3.682 (.493)	4.381
413625	.549 (.241)	5.693	.132 (.023)	4.151	.047 (.010)	5.049	0.0		.729 (.238)	5.292
683090	.300 (.014)	7.771	.136 (.021)	3.562	.149 (.084)	4.999	0.0		.584 (.067)	5.492
463001	i.d.		.937 (.303)	7.098	.655 (.101)	9.776	0.0		1.593 (.305)	8.005

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-56. Seasonal loadings (with 95% confidence interval)$^+$ of nickel at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.052 (.016)	.069	.000 (.000)	.016	0.0		.053 (.016)	.067
413615	++		.002 (.001)	.015	.000 (.000)	.033	.002 (.001)	.020	.004 (.001)	.018
683089	i.d.		.010 (.009)	.027	.004 (.006)	.045	0.0		.014 (.010)	.031
413011	.033 (.000)	.010	i.d.		i.d.		0.0		.033 (.000)	.010
413010	.006 (.000)	.010	.002 (.043)	.014	i.d.		0.0		.008 (.043)	.011
413614	i.d.		.010 (.005)	.075	.000 (.000)	.007	.000 (.000)	.004	.011 (.005)	.059
413625	++		.000 (.000)	.010	.000 (.000)	.027	.000 (.000)	.022	.000 (.000)	.022
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.017 (.011)	.010	.000 (.000)	.000	0.0		0.0		.018 (.011)	.010
					1977					
413616	.018 (.015)	.035	.190 (.068)	.058	.001 (.000)	.004	0.0		.209 (.069)	.052
413615	.016 (.008)	.036	.033 (.016)	.021	.005 (.006)	.021	.002 (.002)	.020	.051 (.019)	.022
683089	.019 (.015)	.028	.012 (.003)	.010	.000 (.000)	.003	0.0		.032 (.016)	.016
413011	.005 (.001)	.015	.023 (.053)	.020	i.d.		0.0		.027 (.053)	.018
413010	.018 (.022)	.079	i.d.		i.d.		0.0		.018 (.022)	.079
413034	.000 (.000)	.013	.002 (.001)	.009	.001 (.000)	.015	0.0		.003 (.001)	.010
413614	.001 (.000)	.008	.005 (.002)	.012	.001 (.000)	.004	0.0		.007 (.002)	.009
413625	.001 (.000)	.009	.001 (.000)	.016	.000 (.000)	.002	0.0		.001 (.000)	.010
683090	.001 (.000)	.015	.000 (.000)	.003	.000 (.000)	.003	0.0		.001 (.000)	.007
463001	i.d.		.001 (.000)	.008	i.d.		0.0		.001 (.000)	.008

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-57. Seasonal loadings (with 95% confidence interval)+ of manganese at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.811 (.293)	1.068	.052 (.009)	1.779	0.0		.863 (.293)	1.095
413615	++		.013 (.006)	.101	.007 (.009)	.499	.030 (.007)	.322	.049 (.009)	.212
683089	i.d.		.043 (.046)	.120	.024 (.071)	.267	0.0		.067 (.081)	.150
413011	.394 (.245)	.121	i.d.		i.d.		0.0		.394 (.245)	.121
413010	.049 (.000	.081	.098 (.335)	.676	i.d.		0.0		.146 (.335)	.326
413614	i.d.		.095 (.024)	.682	.003 (.001)	.171	.002 (.000)	.079	.100 (.024)	.549
413625	++		.000 (.001)	.358	.001 (.005)	.270	.002 (.002)	.367	.004 (.002)	.340
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.202 (.017)	.116	.004 (.003)	.107	0.0		0.0		.206 (.017)	.116
					1977					
413616	.372 (.134)	.731	6.959 (2.628)	2.120	.033 (.004)	.144	0.0		7.364 (2.630)	1.832
413615	.147 (.040)	.333	.629 (.342)	.395	.045 (.023)	.189	.013 (.007)	.131	.834 (.346)	.351
683089	.140 (.103)	.205	.104 (.034)	.083	.003 (.002)	.025	0.0		.246 (.108)	.121
413011	.054 (.008)	.167	.510 (.393)	.445	i.d.		0.0		.567 (.394)	.381
413010	.113 (.012)	.493	.221 (.077)	.342	.010 (.133)	.161	0.0		.394 (.111)	.420
413034	.011 (.003)	.513	.047 (.017)	.195	.086 (.362)	1.266	0.0		.144 (.361)	.436
413614	.015 (.009)	.108	.055 (.023)	.120	.026 (.009)	.107	0.0		.096 (.025)	.114
413625	.010 (.003)	.100	.013 (.006)	.401	.001 (.000)	.100	0.0		.023 (.006)	.170
683090	.001 (.000)	.020	.002 (.001)	.049	.001 (.001)	.027	0.0		.003 (.001)	.033
463001	i.d.		.112 (.120)	.848	.007 (.003)	.104	0.0		.119 (.120)	.598

+ () 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-58. Seasonal loadings (with 95% confidence interval)+ of chromium at the predominantly single land use monitoring sites

STORET number	Spring Loading, kg/ha	Spring Conc., mg/L	Summer Loading, kg/ha	Summer Conc., mg/L	Fall Loading, kg/ha	Fall Conc., mg/L	Winter Loading, kg/ha	Winter Conc., mg/L	Total Loading, kg/ha	Total Conc., mg/L
					1976					
413616	++		.214 (.320)	.282	.001 (.000)	.049	0.0		.215 (.320)	.273
413615	++		.002 (.001)	.013	.000 (.000)	.032	.005 (.001)	.056	.007 (.001)	.031
683089	i.d.		.011 (.013)	.032	.002 (.002)	.022	0.0		.014 (.014)	.027
413011	.007 (.008)	.002	i.d.		i.d.		0.0		.007 (.008)	.002
413010	.002 (.001)	.003	.004 (.064)	.028	i.d.		0.0		.007 (.064)	.009
413614	i.d.		.004 (.001)	.028	.000 (.000)	.018	.000 (.000)	.014	.005 (.001)	.025
413625	++		.000 (.000)	.006	.000 (.000)	.026	.000 (.000)	.041	.000 (.000)	.033
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.010 (.008)	.006	.000 (.001)	.000	0.0		0.0		.010 (.008)	.006
					1977					
413616	.018 (.012)	.035	.287 (.078)	.088	.004 (.004)	.017	0.0		.309 (.078)	.077
413615	.015 (.004)	.034	.061 (.029)	.038	.015 (.013)	.062	.004 (.006)	.040	.094 (.036)	.040
683089	.011 (.009)	.016	.020 (.006)	.016	.000 (.000)	.002	0.0		.032 (.011)	.016
413011	.004 (.002)	.012	.041 (.033)	.036	i.d.		0.0		.046 (.033)	.031
413010	.017 (.017)	.074	.029 (.016)	.045	.000 (.006)	.000	0.0		.046 (.021)	.049
413034	.001 (.002)	.026	.004 (.002)	.015	.005 (.001)	.076	0.0		.009 (.002)	.029
413614	.001 (.000)	.006	.005 (.001)	.011	.003 (.000)	.011	0.0		.009 (.001)	.010
413625	.001 (.000)	.008	.000 (.000)	.013	.000 (.000)	.001	0.0		.001 (.000)	.009
683090	.000 (.000)	.005	.000 (.000)	.003	.000 (.000)	.001	0.0		.000 (.000)	.003
463001	i.d.		.005 (.006)	.038	.000 (.000)	.000	0.0		.005 (.006)	.025

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-59. Seasonal loadings (with 95% confidence interval)+ of lead at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		1.440 (.986)	1.897	.023 (.019)	.780	0.0		1.462 (.986)	1.855
413615	++		.038 (.021)	.300	.026 (.039)	1.935	.256 (.088)	2.775	.320 (.091)	1.376
683089	i.d.		.189 (.151)	.528	.041 (.054)	.456	0.0		.230 (.160)	.514
413011	.180 (.111)	.055	i.d.		i.d.		0.0		.180 (.111)	.05
413010	.061 (.017)	.100	.077 (.365)	.531	i.d.		0.0		.138 (.371)	.184
413614	i.d.		.081 (.026)	.584	.004 (.001)	.209	.004 (.001)	.161	.089 (.026)	.489
413625	++		.000 (.000)	.200	.000 (.000)	.056	.010 (.003)	1.464	.010 (.003)	.957
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.007 (.005)	.004	.000 (.000)	.000	0.0		0.0		.007 (.005)	.004
					1977					
413616	.307 (.122)	.604	6.664 (2.910)	2.030	.041 (.006)	.178	0.0		7.013 (2.912)	1.744
413615	1.095 (.345)	2.471	3.659 (2.009)	2.296	.337 (.240)	1.421	.078	.783	5.169 (2.060)	2.178
683089	.714 (.581)	1.044	.443 (.161)	.356	.010 (.006)	.101	0.0		1.167 (.600)	.574
413011	.025 (.007)	.073	.191 (.075)	.167	i.d.		0.0		.216 (.076)	.145
413010	.507 (.538)	2.214	.285 (.087)	.440	.014 (.048)	.226	0.0		.805 (.550)	.858
413034	.021 (.054)	.975	.072 (.019)	.298	.109 (.040)	1.604	0.0		.202 (.041)	.611
413614	.025 (.014)	.179	.086 (.050)	.189	.038 (.008)	.157	0.0		.150 (.051)	.178
413625	.007 (.008)	.074	.006 (.002)	.192	.001 (.000)	.086	0.0		.014 (.008)	.102
683090	.001 (.000)	.030	.003 (.000)	.072	.002 (.000)	.060	0.0		.006 (.000)	.053
463001	i.d.		.008 (.007)	.061	.004 (.001)	.060	0.0		.012 (.007)	.060

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-60. Seasonal loadings (with 95% confidence interval)$^+$ of zinc at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		1.730 (.529)	2.279	.050 (.036)	1.710	0.0		1.780 (.529)	2.258
413615	++		.038 (.009)	.297	.019 (.011)	1.362	.081 (.020)	.884	.138 (.021)	.592
683089	i.d.		.078 (.041)	.218	.021 (.015)	.233	0.0		.100 (.044)	.224
413011	.254 (.171)	.078	i.d.		i.d.		0.0		.254 (.171)	.078
413010	.074 (.015)	.122	.068 (.244)	.469	i.d.		0.0		.142 (.251)	.189
413614	i.d.		.103 (.016)	.744	.009 (.003)	.499	.006 (.001)	.235	.118 (.017)	.650
413625	++		.000 (.001)	.386	.000 (.000)	.080	.005 (.009)	.778	.006 (.006)	.552
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.086 (.060)	.049	.000 (.001)	.000	0.0		0.0		.087 (.060)	.049
					1977					
413616	.742 (.296)	1.460	11.846 (3.413)	3.609	.100 (.013)	.057	0.0		12.688 (3.423)	3.156
413615	.471 (.101)	1.063	1.285 (.540)	.806	.128 (.088)	.540	.037 (.034)	.371	1.921 (.563)	.809
683089	.374 (.209)	.547	.209 (.069)	.168	.002 (.002)	.018	0.0		.585 (.218)	.288
413011	.047 (.010)	.137	.238 (.119)	.208	i.d.		0.0		.285 (.119)	.192
413010	.208 (.164)	.908	.193 (.043)	.298	.009 (.067)	.145	0.0		.410 (.165)	.437
413034	.012 (.020)	.558	.057 (.022)	.238	.048 (.015)	.698	0.0		.117 (.025)	.353
413614	.048 (.011)	.338	.156 (.038)	.342	.087 (.036)	.362	0.0		.292 (.043)	.347
413625	.010 (.001)	.104	.004 (.002)	.121	.000 (.000)	.011	0.0		.014 (.002)	.102
683090	.012 (.006)	.299	.002 (.001)	.063	.001 (.001)	.032	0.0		.015 (.006)	.140
463001	i.d.		.024 (.022)	.182	.001 (.000)	.015	0.0		.024 (.022)	.121

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-61. Seasonal loadings (with 95% confidence interval)⁺ of copper at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.115 (.055)	.152	.004 (.001)	.141	0.0		.119 (.055)	.151
413615	++		.008 (.003)	.064	.002 (.002)	.141	.018 (.004)	.195	.028 (.005)	.120
683089	i.d.		.010 (.005)	.029	.001 (.001)	.011	0.0		.011 (.005)	.025
413011	.037 (.018)	.011	i.d.		i.d.		0.0		.037 (.018)	.011
413010	.012 (.002)	.020	.016 (.122)	.110	i.d.		0.0		.028 (.122)	.037
413614	i.d.		.008 (.003)	.058	.001 (.000)	.031	.001 (.000)	.047	.010 (.003)	.054
413625	++		.000 (.000)	.062	.000 (.000)	.023	.001 (.000)	.091	.001 (.000)	.070
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.046 (.067)	.026	.000 (.000)	.000	0.0		0.0		.046 (.067)	.026
					1977					
413616	.073 (.019)	.143	1.215 (.399)	.370	.014 (.003)	.061	0.0		1.302 (.399)	.324
413615	.087 (.019)	.197	.275 (.079)	.173	.043 (.040)	.183	.113 (.018)	.131	.418 (.101)	.176
683089	.075 (.030)	.110	.057 (.013)	.046	.002 (.001)	.015	0.0		.134 (.033)	.066
413011	.012 (.005)	.035	.094 (.023)	.082	i.d.		0.0		.106 (.023)	.071
413010	.055 (.329)	.240	.084 (.018)	.130	.010 (.209)	.161	0.0		.149 (.333)	.159
413034	.003 (.007)	.138	.016 (.004)	.068	.008 (.002)	.119	0.0		.027 (.006)	.083
413614	.007 (.001)	.050	.017 (.005)	.038	.009 (.003)	.038	0.0		.034 (.005)	.040
413625	.004 (.003)	.038	.001 (.000)	.044	.000 (.000)	.014	0.0		.005 (.003)	.037
683090	.001 (.000)	.031	.001 (.000)	.037	.000 (.000)	.012	0.0		.003 (.000)	.028
463001	i.d.		.010 (.005)	.076	.002 (.001)	.030	0.0		.012 (.006)	.060

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-62. Seasonal loadings (with 95% confidence interval)+ of cadmium at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.019 (.008)	.025	i.d.		0.0		.019 (.008)	.025
413615	++		.002 (.002)	.013	.000 (.000)	.007	.001 (.000)	.007	.002 (.002)	.010
683089	i.d.		.002 (.001)	.004	.000 (.000)	.003	0.0		.002 (.001)	.004
413011	.001 (.000)	.000	i.d.		i.d.		0.0		.001 (.000)	.000
413010	.001 (.001)	.002	.001 (.003)	.007	i.d.		0.0		.002 (.001)	.003
413614	i.d.		.001 (.000)	.006	.000 (.000)	.004	.000 (.000)	.003	.001 (.000)	.005
413625	++		.000 (.000)	.004	i.d.		.000 (.000)	.005	.000 (.000)	.004
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.002 (.001)	.001	.000 (.000)	.000	0.0		0.0		.002 (.001)	.001
					1977					
413616	.006 (.002)	.012	.082 (.021)	.025	.001 (.003)	.004	0.0		.088 (.021)	.022
413615	.004 (.001)	.009	.011 (.003)	.007	.002 (.001)	.007	.001 (.001)	.007	.018 (.004)	.007
683089	.006 (.003)	.009	.006 (.002)	.005	.000 (.000)	.002	0.0		.013 (.003)	.006
413011	.001 (.000)	.003	.002 (.001)	.002	i.d.		0.0		.002 (.001)	.001
413010	.005 (.050)	.022	.002 (.001)	.003	.000 (.001)	.000	0.0		.007 (.050)	.007
413034	.000 (.000)	.008	.001 (.000)	.003	.000 (.001)	.007	0.0		.001 (.000)	.005
413614	.001 (.000)	.007	.002 (.001)	.005	.003 (.002)	.011	0.0		.006 (.001)	.007
413625	.001 (.001)	.015	.000 (.000)	.003	.000 (.000)	.001	0.0		.002 (.001)	.011
683090	.000 (.000)	.004	.000 (.000)	.004	.000 (.000)	.001	0.0		.000 (.000)	.003
463001	i.d.		.000 (.000)	.000	.000 (.001)	.000	0.0		.000 (.000)	.000

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

Table II-A-63. Seasonal loadings (with 95% confidence interval)[+] of arsenic at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Winter		Total	
	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L	Loading, kg/ha	Conc., mg/L
					1976					
413616	++		.017 (.003)	.022	.000 (.001)	.007	0.0		.017 (.003)	.021
413615	++		.001 (.001)	.011	.000 (.000)	.006	.001 (.000)	.007	.002 (.000)	.009
683089	i.d.		.003 (.003)	.006	.003 (.001)	.034	0.0		.009 (.005)	.013
413011	.016 (.000)	.005	i.d.		i.d.		0.0		.016 (.000)	.005
413010	.003 (.000)	.005	.001 (.064)	.007	i.d.		0.0		.004 (.064)	.005
413614	i.d.		.002 (.001)	.017	.000 (.000)	.002	.000 (.000)	.007	.003 (.001)	.014
413625	++		.000 (.000)	.007	.000 (.000)	.004	.000 (.000)	.003	.000 (.000)	.004
683090	i.d.		0.0		0.0		0.0		0.0	
463001	.009 (.011)	.005	.000 (.000)	.000	0.0		0.0		.009 (.011)	.005
					1977					
413616	.004 (.001)	.007	.044 (.015)	.013	.000 (.000)	.003	0.0		.048 (.015)	.012
413615	.003 (.001)	.008	.002 (.002)	.006	.000 (.000)	.010	.002 (.006)	.020	.014 (.002)	.006
683089	.005 (.003)	.008	.006 (.002)	.005	.000 (.001)	.004	0.0		.012 (.003)	.006
413011	.002 (.001)	.006	.006 (.000)	.005	i.d.		0.0		.007 (.001)	.005
413010	.002 (.001)	.009	i.d.		i.d.		0.0		.002 (.001)	.009
413034	.000 (.000)	.005	.001 (.000)	.003	.000 (.000)	.005	0.0		.001 (.000)	.004
413614	.001 (.000)	.004	.003 (.000)	.006	.001 (.000)	.003	0.0		.004 (.000)	.005
413625	.000 (.000)	.003	.000 (.000)	.005	.000 (.000)	.002	0.0		.000 (.000)	.003
683090	.000 (.000)	.005	.000 (.000)	.003	.000 (.000)	.002	0.0		.000 (.000)	.004
463001	i.d.		.001 (.000)	.008	i.d.		0.0		.001 (.000)	.008

+ ( ) 95% Confidence interval
++ Station not operational
i.d. Data insufficient for loading determination

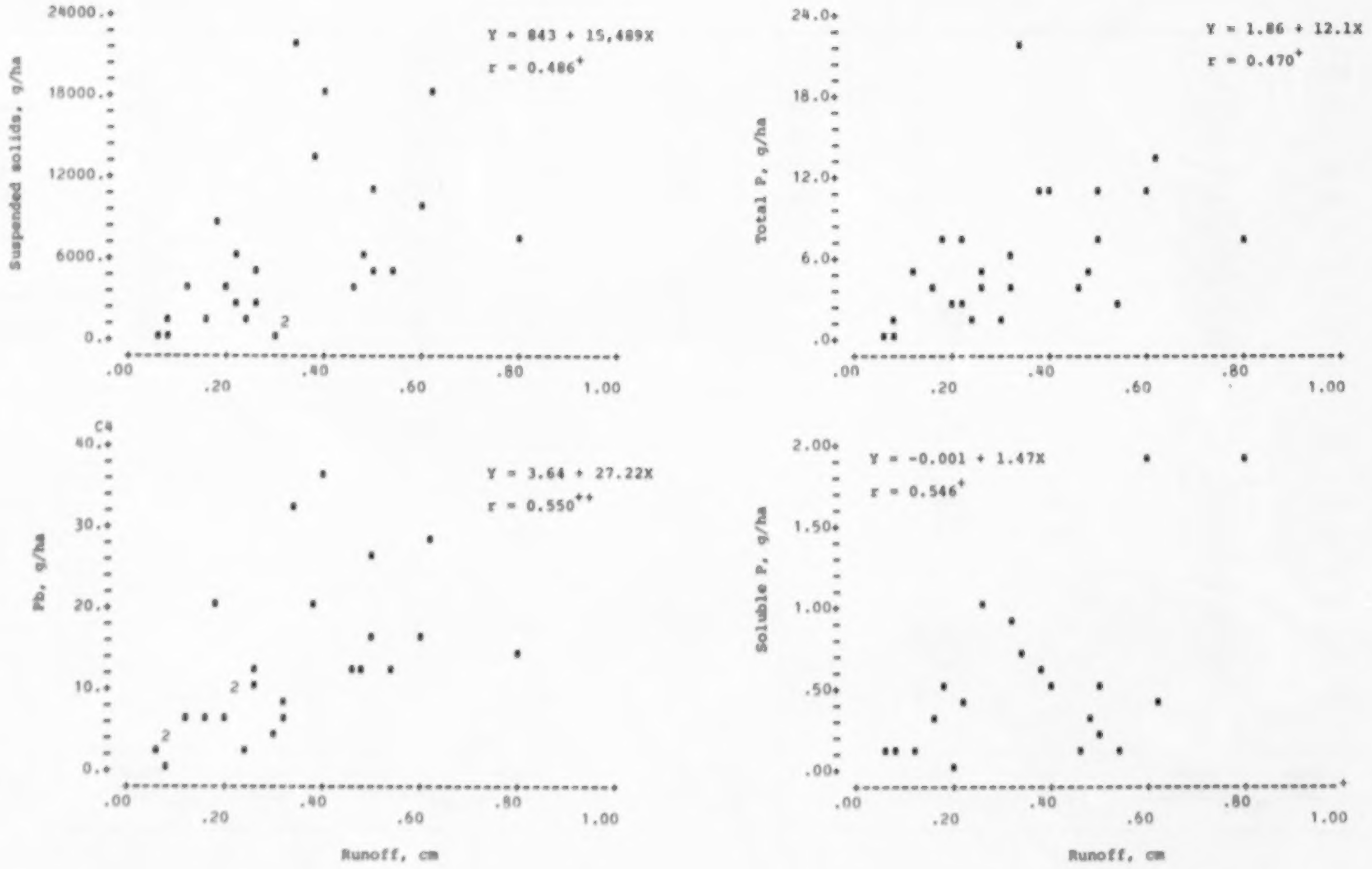


Fig. II-A-16. Relationships of parameter loadings and runoff at Brookfield Square Shopping Center (683089) ($^{+}$Significant at P = 0.05; $^{++}$significant at P = 0.01).

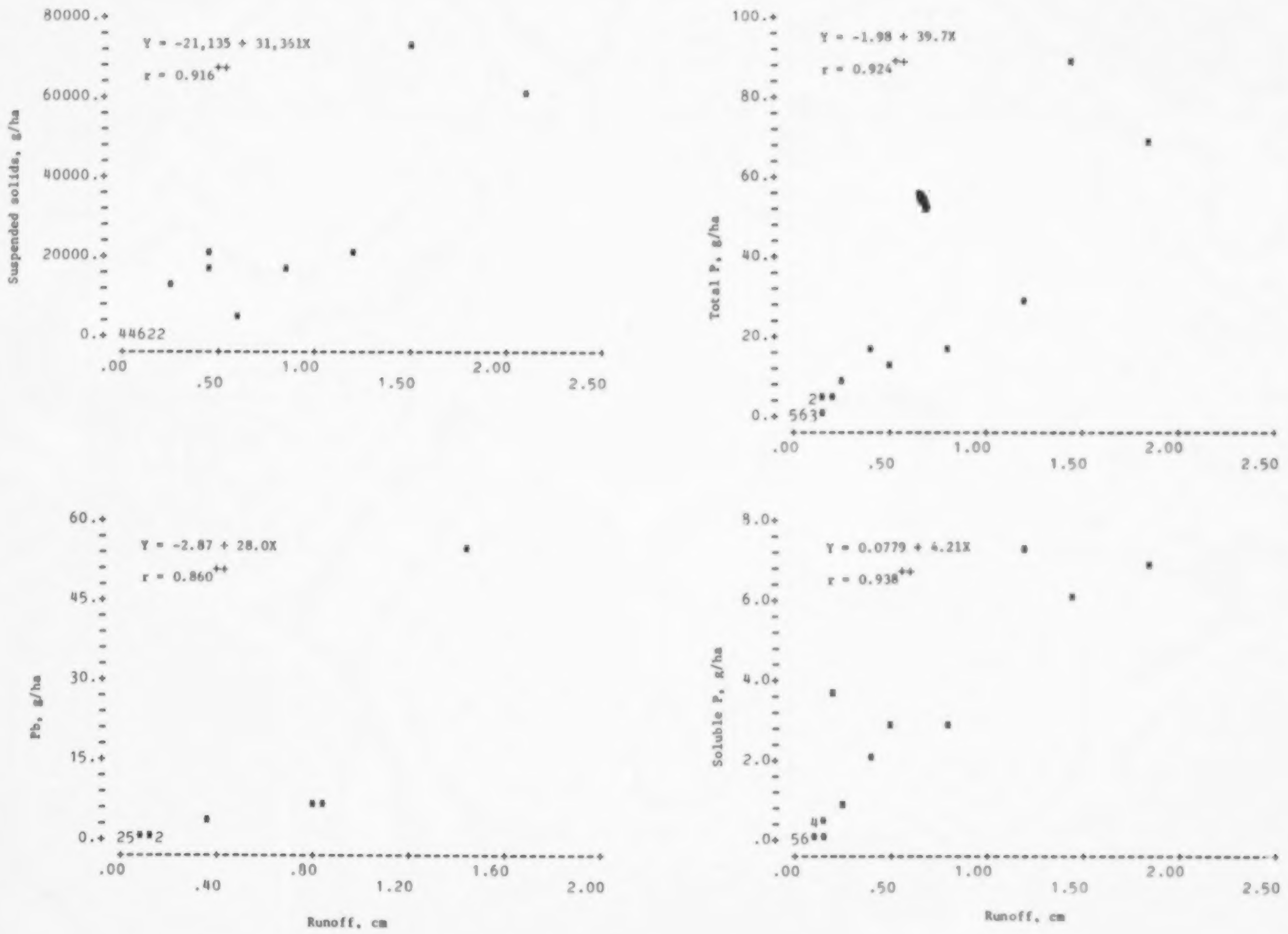


Fig. II-A-15. Relationships of parameter loadings and runoff at Noyes Creek (413011) ($^{++}$Significant at P = 0.01)

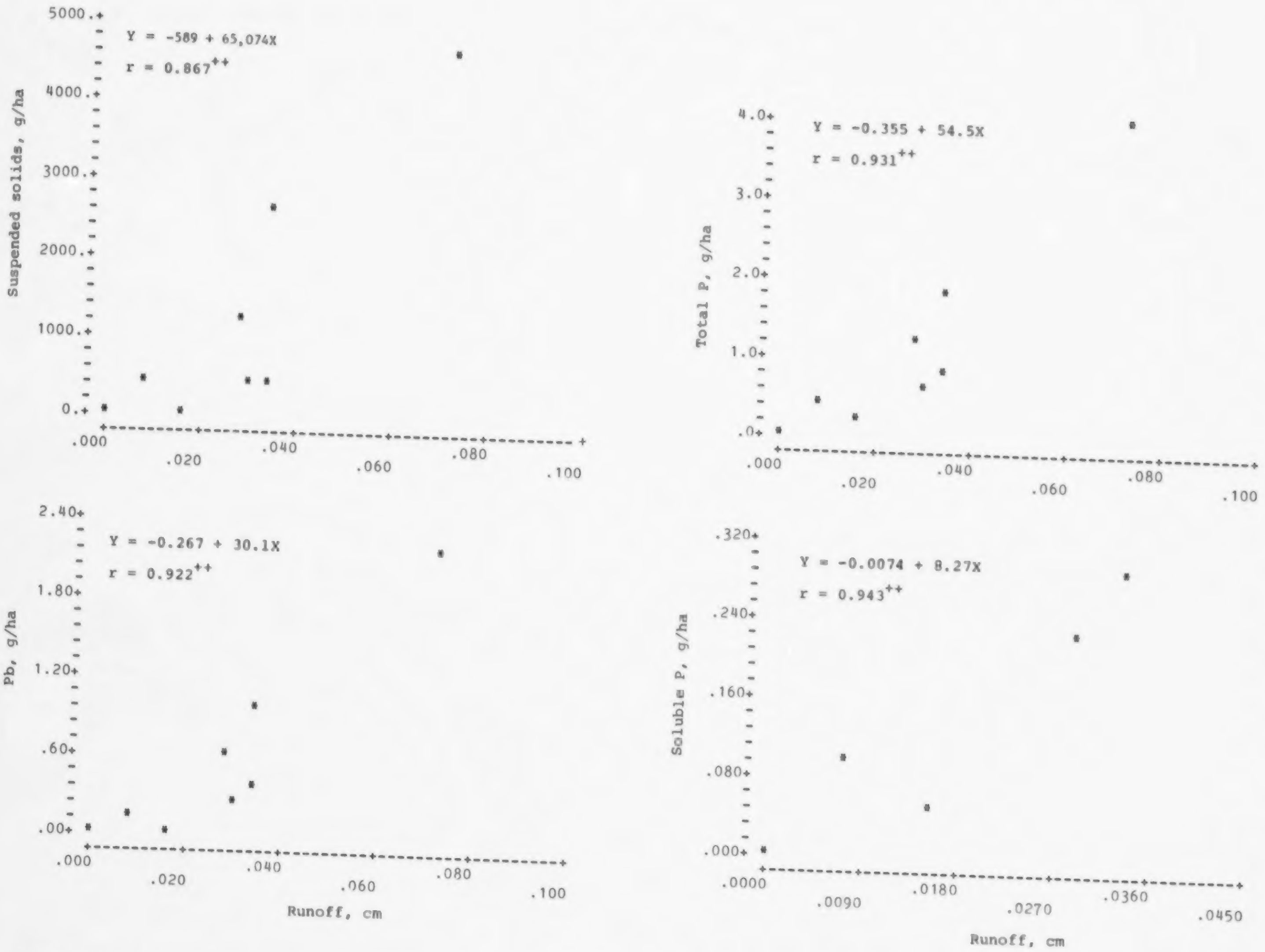


Fig. II-A-16. Relationships of parameter loadings and runoff at New Berlin (413625) ($^{++}$Significant at P = 0.01)

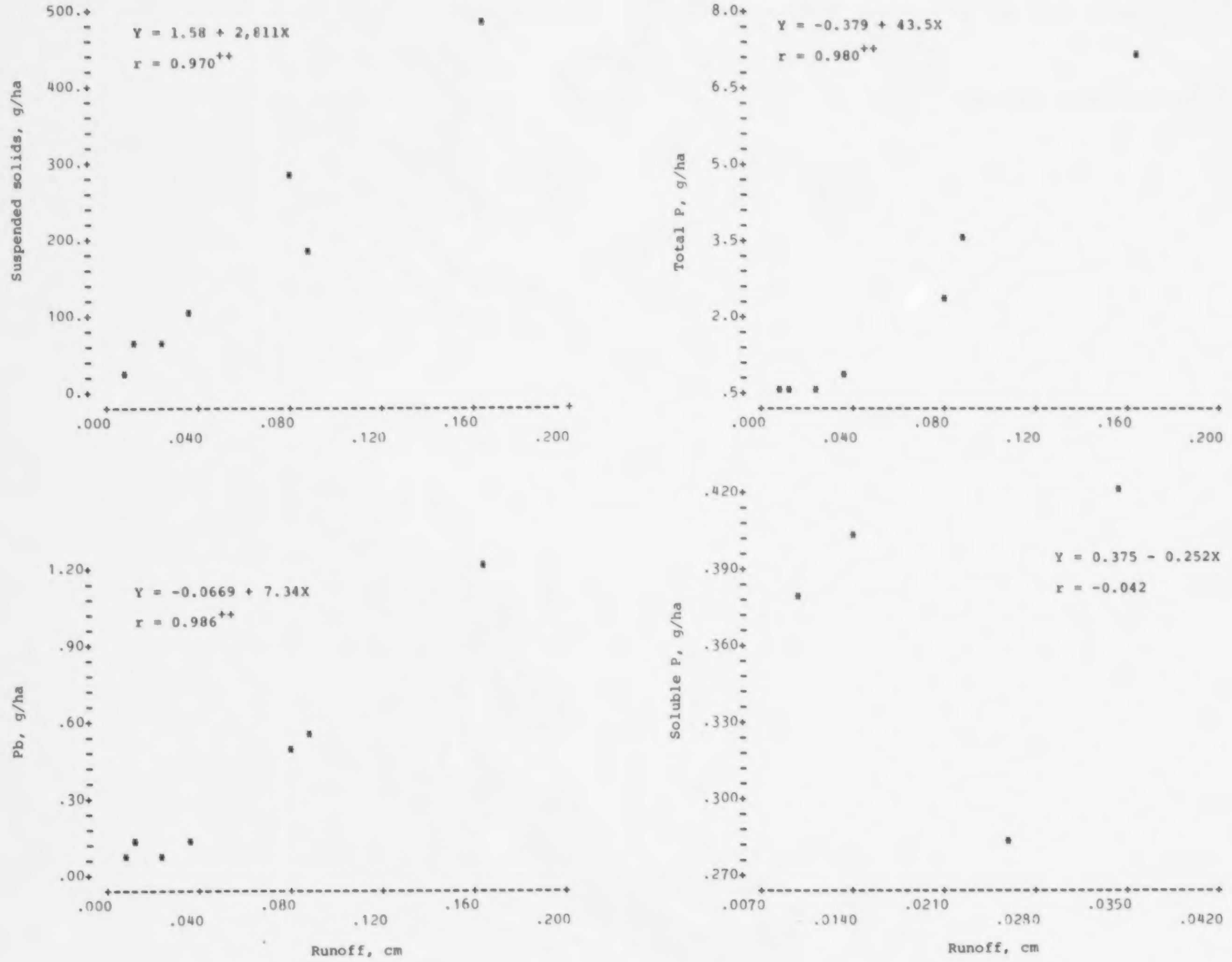


Fig. II-A-17. Relationships of parameter loadings and runoff at Elm Grove (683090) ($^{++}$Significant at P = 0.01)

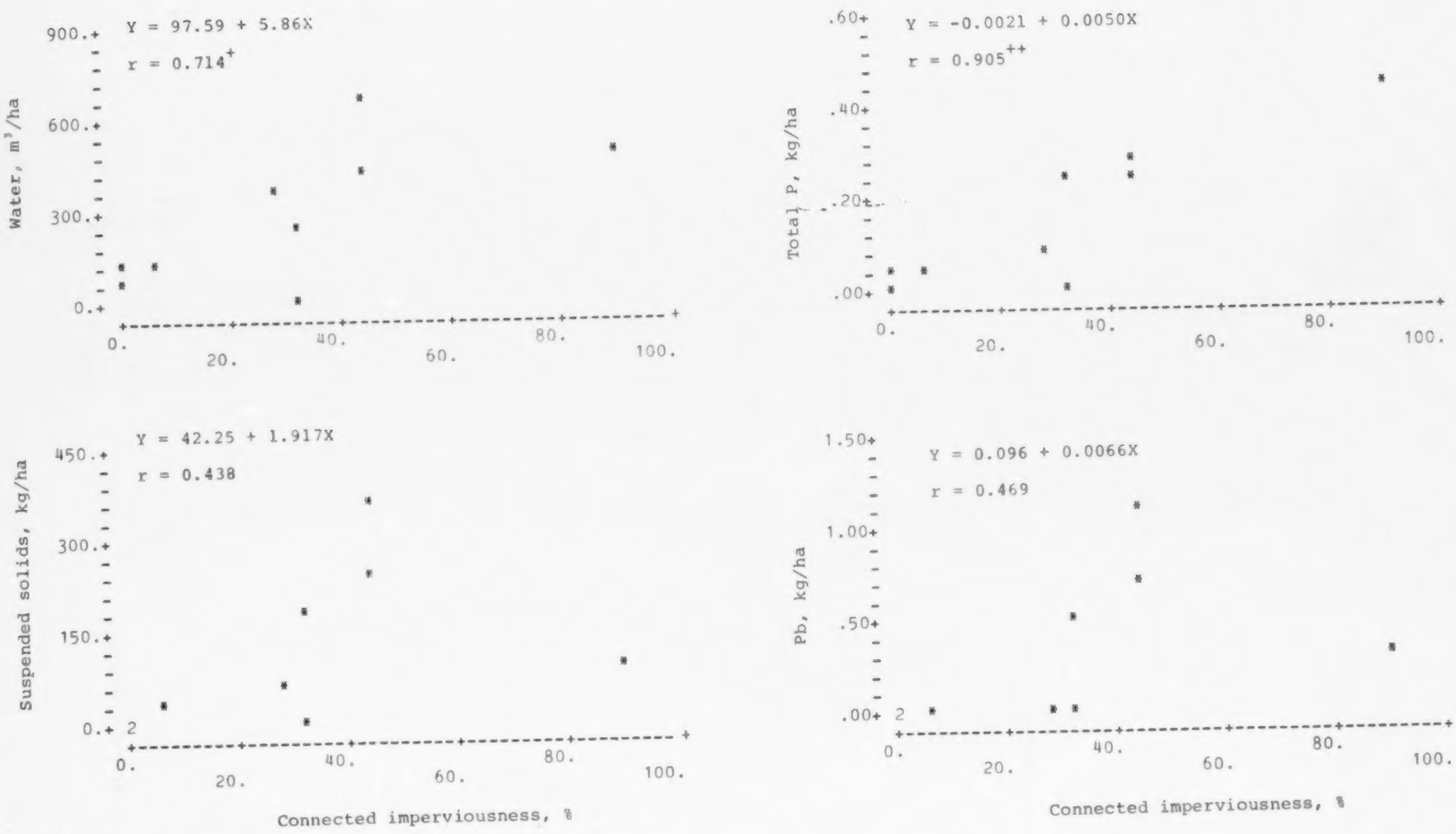


Fig. II-A-18. Relationships of parameter loadings and degree of connected imperviousness - spring, 1977 ($^{+}$Significant at P = 0.05. $^{++}$Significant at P = 0.01)

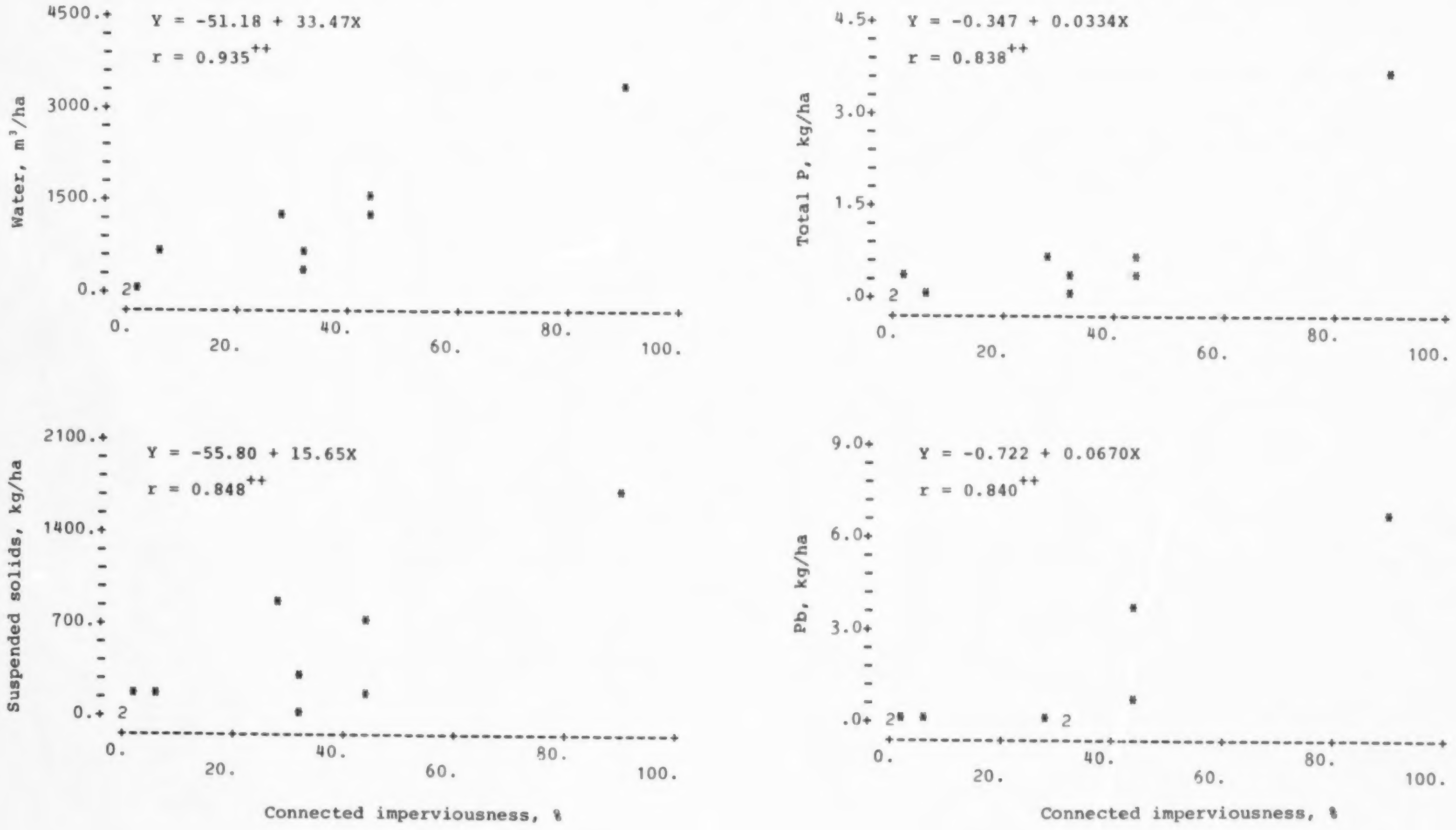


Fig. II-A-19. Relationships of parameter loadings and degree of connected imperviousness - summer, 1977 ($^{++}$Significant at P = 0.01)

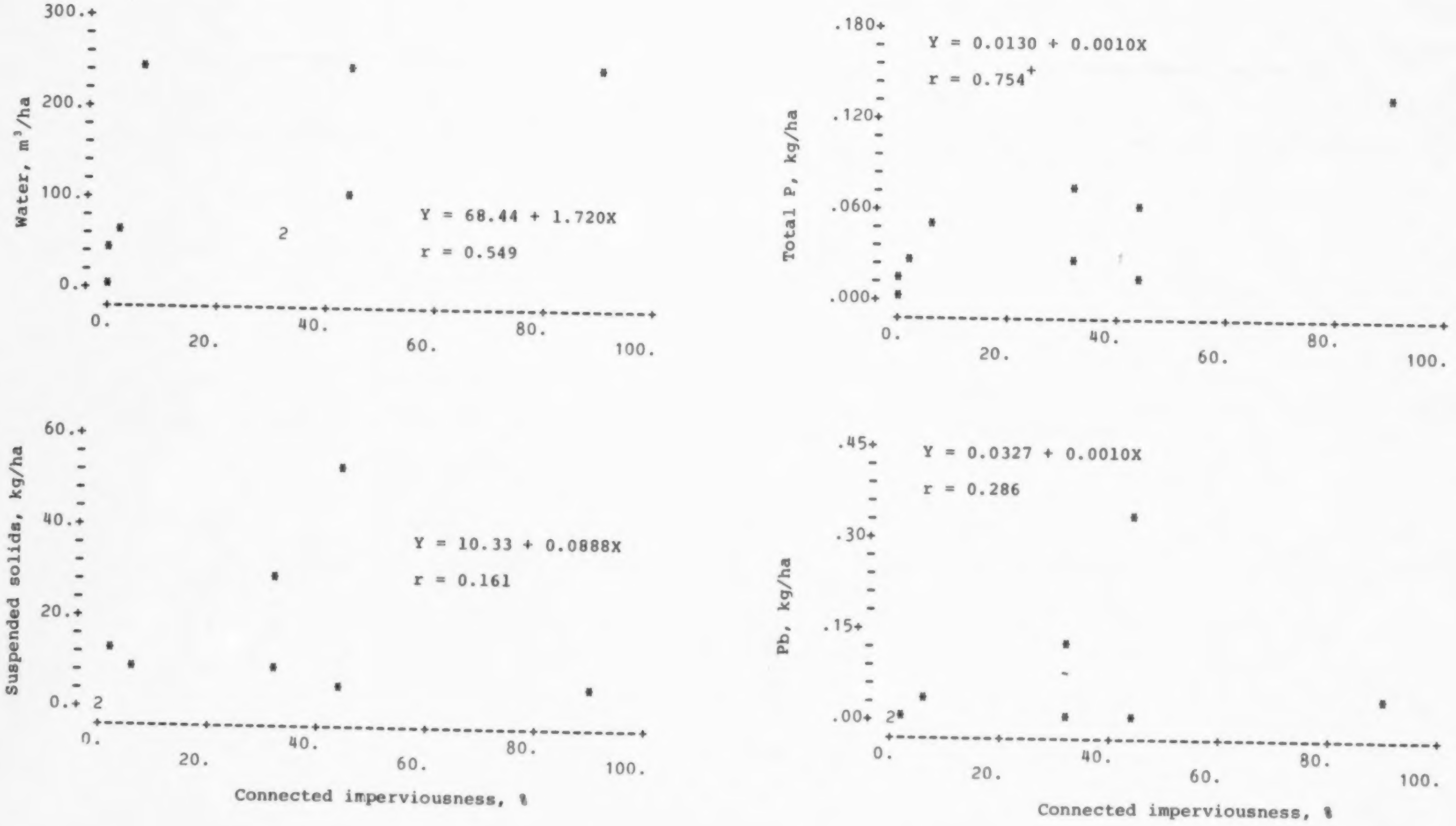


Fig. II-A-20. Relationships of parameter loadings and degree of connected imperviousness - fall, 1977 ($^+$Significant at P = 0.05)

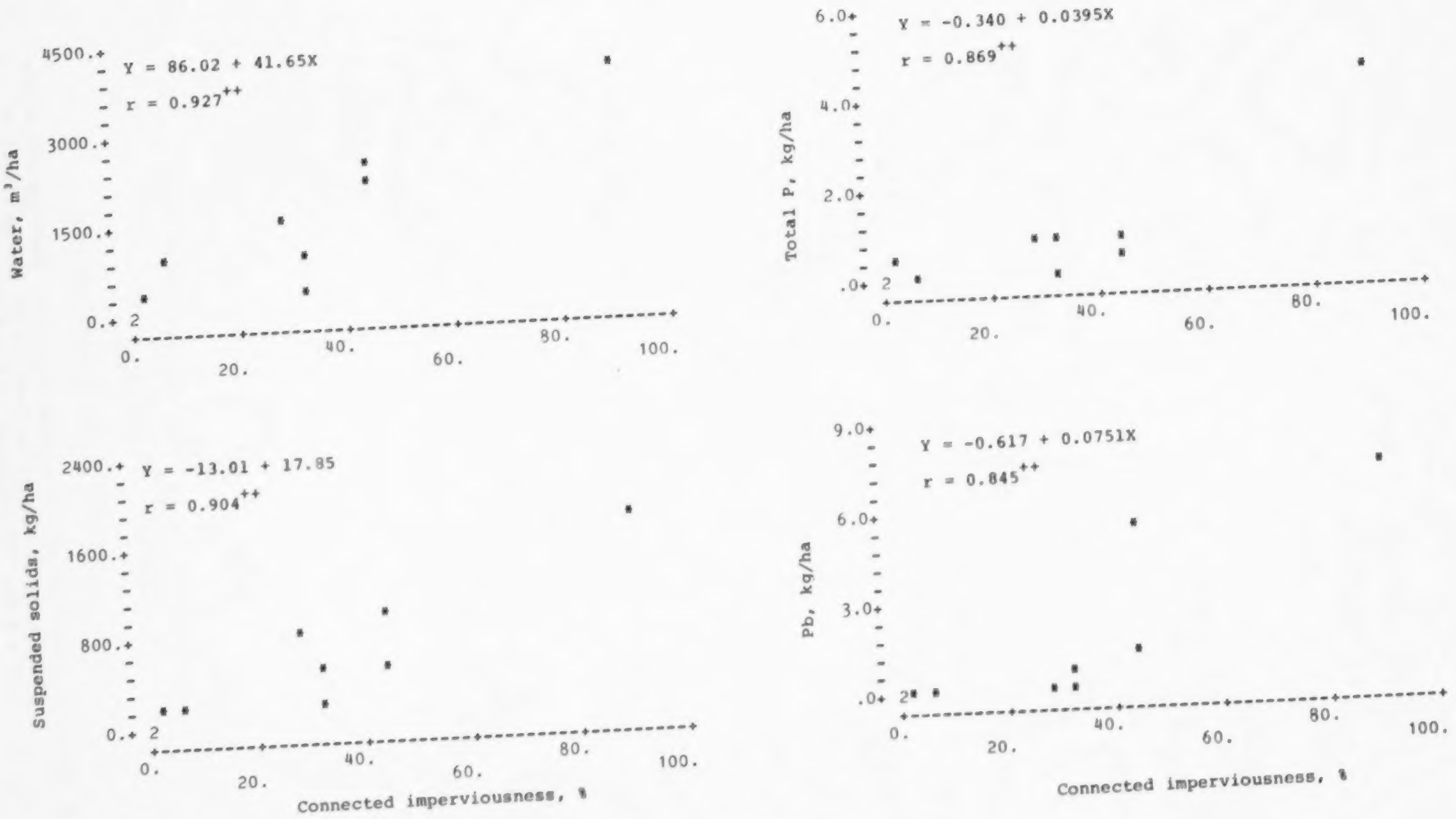


Fig. II-A-21. Relationships of parameter loadings and degree of connected imperviousness - annual, 1977 (++Significant at P = 0.01)

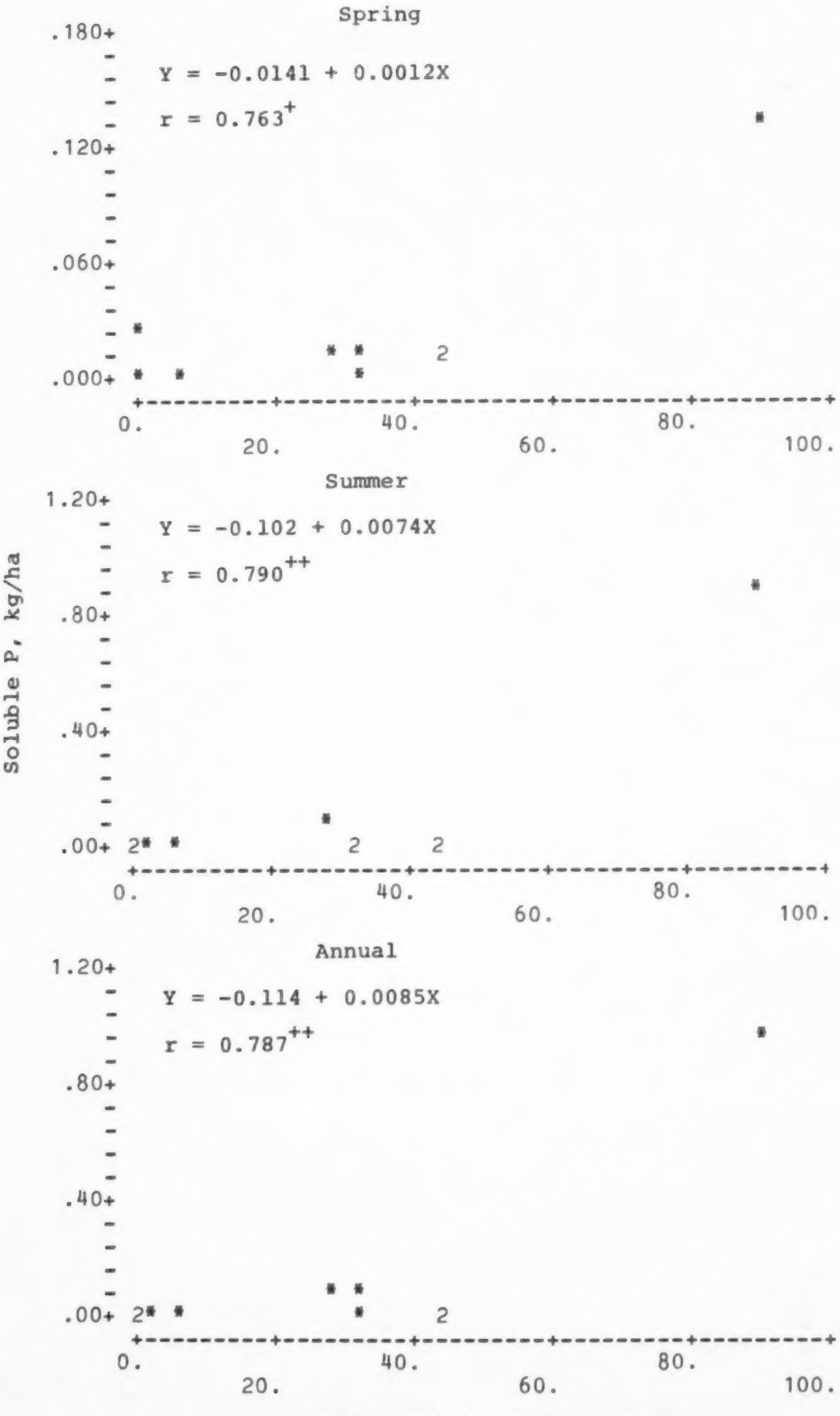


Fig. II-A-22. Relationships of soluble phosphorus loadings and degree of connected imperviousness - 1977 ($^+$Significant at P = 0.05, $^{++}$Significant at P = 0.01)

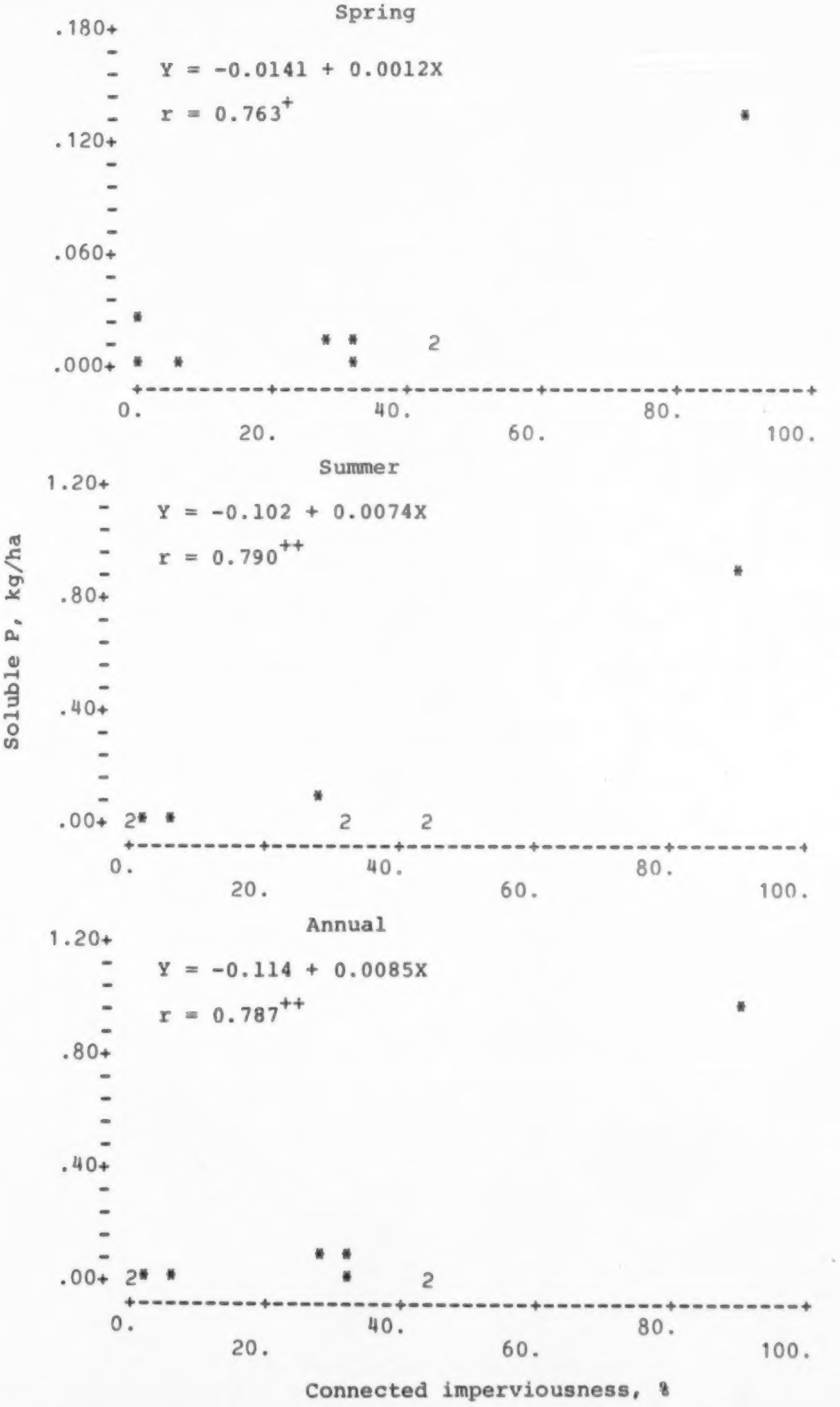


Fig. II-A-22. Relationships of soluble phosphorus loadings and degree of connected imperviousness - 1977 ($^{+}$Significant at P = 0.05, $^{++}$Significant at P = 0.01)

Table II-A-64. Observed rainfall and runoff at the predominantly single land use monitoring sites*

Date	413615			683089			413011			413010			413614			463601		
	Rainfall cm	Runoff		Rainfall, cm	Runoff		Rainfall, cm	Runoff		Rainfall, cm	Runoff		Rainfall, cm	Runoff		Rainfall, cm	Runoff	
		cm	%		cm	%		cm	%		cm	%		cm	%		cm	%
770504		0.051	20				0.41	0.025	6.1	0.33	0.025	7.6						
770505				0.51	0.10	20												
770521							0.15	0.015	10									
770531	0.58	0.10	17				0.25	0.051	20									
770605	2.03	0.43	21	1.40	0.43	31	4.85	1.04	21									
770605	1.78	0.58	32							2.08	0.36	17				3.15	0.025	0.8
770608	0.66	0.15	23	0.56	0.10	18	1.12	0.20	18	0.64	0.076	12						
770611							4.67	1.55	33	1.55	0.33	21	2.77	0.43	16			
770617	1.78	0.43	24	1.52	0.58	38	1.32	0.30	23	2.21	0.18	8.1	1.98	0.18	9.1			
770624							0.79	0.20	25									
770628	1.65	0.36	22	1.02	0.22	22	0.94	0.13	14	1.50	0.18	12						
770630	1.78	0.46	26				1.07	0.18	17	1.96	0.30	15	1.27	0.076	6.0			
770703							1.73	0.36	21	0.84	0.10	12				1.04	0.013	1.2
770706				0.91	0.15	16	0.48	0.051	11	0.61	0.18	30	0.41	0.23	56			
770717				9.53	2.29	24	2.59	2.06	80	4.14	1.75	42						
770718							0.51	0.025	4.9							3.86	0.051	1.3
770720	0.25	0.051	20	0.43	0.10	23				0.86	0.10	12				2.01	0.010	0.5
770721													0.38	0.025	6.6			
770724	1.27	0.25	20	2.29	0.62	27	1.07	0.20	19	1.45	0.28	19	1.30	0.10	7.7	1.91	0.010	0.5
770802	0.25	0.025	10	0.76	0.15	20				0.28	0.10	36						
770803							1.17	0.25	21	1.22	0.20	16	1.02	0.064	6.3	3.12	0.36	12
770804	0.25	0.051	20	0.76	0.28	37				0.28	0.025	8.9	0.51	0.025	4.9			
770805	0.51	0.28	55	0.56	0.18	32	0.23	0.002	0.9	0.76	0.051	6.7	0.38	0.013	3.4			
770808	0.76	0.051	6.7	0.74	0.23	31	0.46	0.018	3.9	0.74	0.10	14	0.51	0.038	7.4			
770809	0.64	0.076	12	1.07	0.58	54	1.14	0.53	46	0.51	0.10	20	1.27	0.10	7.9			
770813	3.30	0.71	22	3.28	0.95	29	2.67	0.81	30	2.46	0.56	23	4.39	0.71	16	2.69	0.025	0.9
770816				0.51	0.026	5.1	0.30	0.020	6.7	0.41	0.051	12						
770821	0.51	0.076	15				0.30	0.020	6.7	0.48	0.025	5.2	0.51	0.015	2.9			
770828	2.79	1.19	43	4.27	1.45	34	4.37	1.24	28	3.33	0.61	18	3.81	0.43	11	3.89	0.17	4.4
770901	0.51	0.076	15	1.30	0.35	27	0.38	0.076	20	0.71	0.25	35	0.36	0.051	14			
770904	0.30	0.051	17	0.25	0.075	30	0.33	0.025	7.6	0.33	0.051	15						
770912							1.63	0.33	20	1.42	0.13	9.2				1.57	0.005	0.3
770915							0.25	0.020	8.0	0.33	0.025	7.6						
770917	1.75	0.20	11	1.70	0.31	18	0.79	0.076	9.6	0.79	0.10	13				1.14	0.013	1.1
770918							0.64	0.13	20	0.76	0.13	17						
770923							2.49	0.96	38							2.46	0.20	8.1
770925							0.15	0.010	6.7									
770930	2.89	0.46	16	2.54	0.51	20				2.34	0.58	25						

Blank indicates that either rainfall or runoff data is not available.

*At site 413625, rainfall and runoff on 770605 was 3.68 cm and 0.076 cm (2.1%), respectively; on 770828, 3.05 cm and 0.010 cm (3.3%), respectively.
At site 683090 rainfall and runoff on 770813 was 3.43 cm and 0.010 cm (2.9%), respectively; on 770828, 4.32 cm and 0.15 cm (3.5%), respectively.

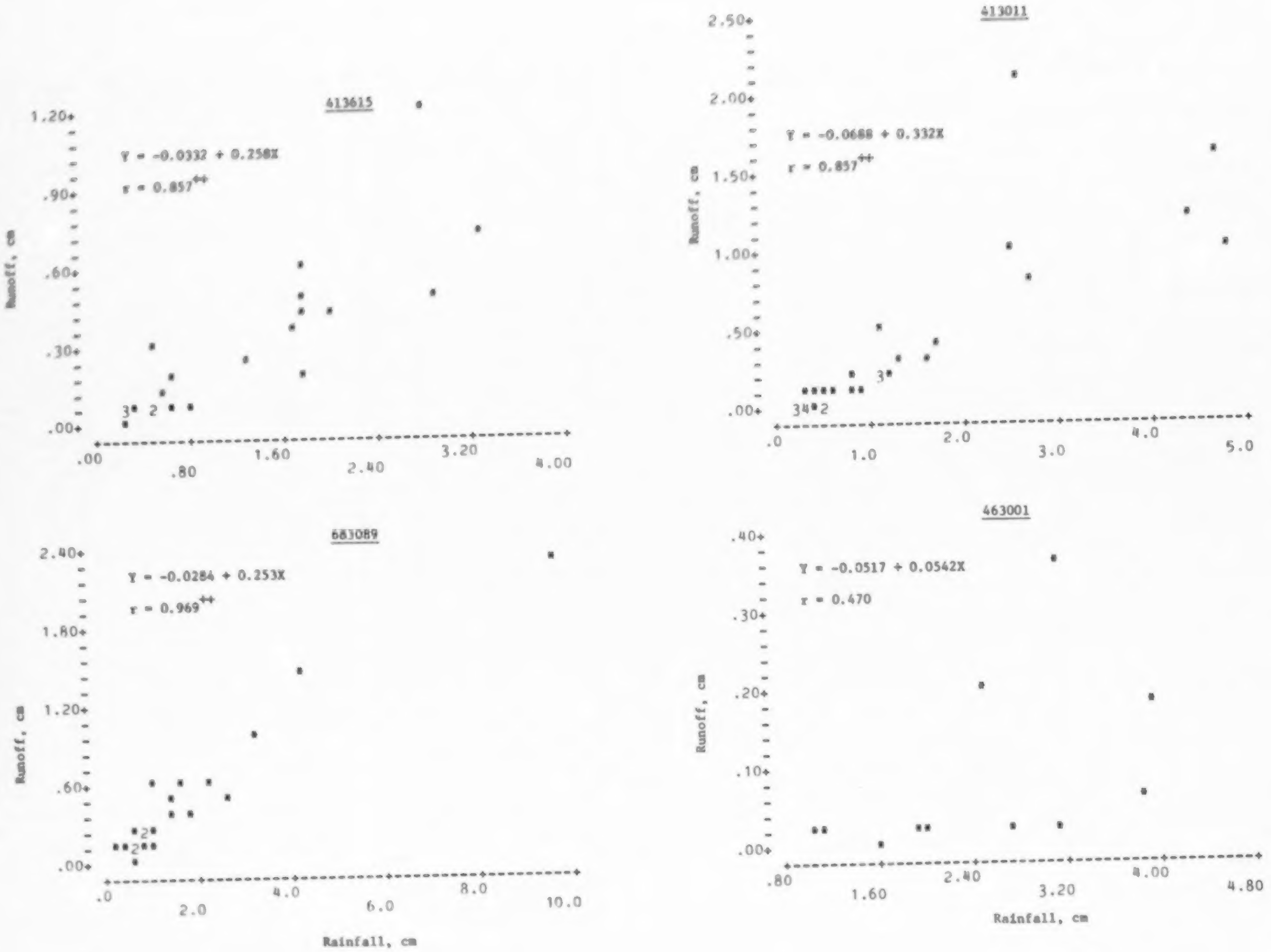


Fig. II-A-23. Relationships of amount of runoff and rainfall at selected sites ($^{++}$Significant at P = 0.01).

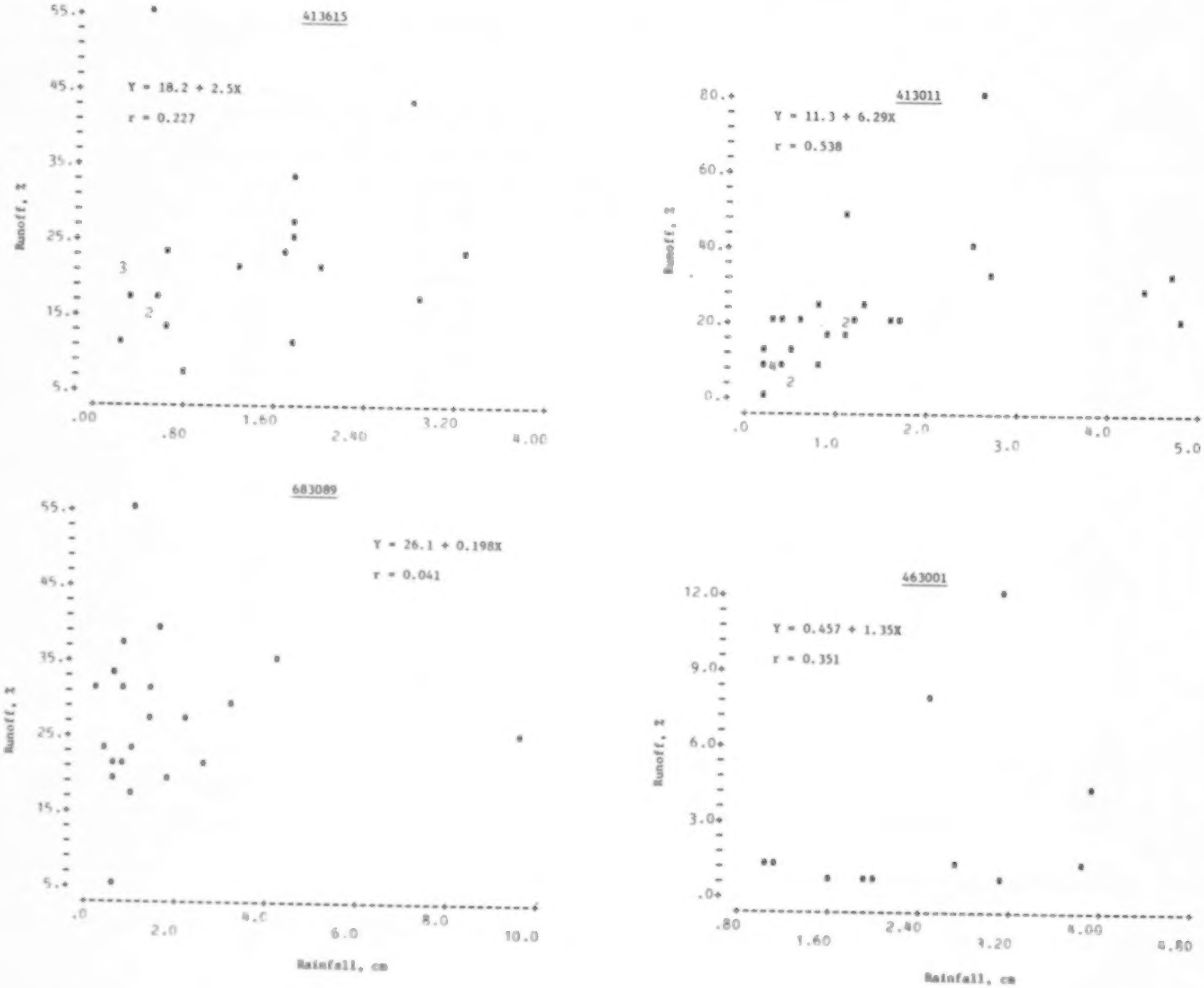


Fig. II-A-24. Relationships of percentage of runoff and rainfall at selected sites.

Table II-A-65. Seasonal and annual rainfall* and runoff at the predominantly single land use monitoring sites

STORET number	Spring		Summer		Fall		Annual	
	Rainfall, cm	Runoff, %	Rainfall, cm	Runoff, %	Rainfall, cm	Runoff, %	Rainfall,** cm	Runoff, %
				1976				
413616	37.19	+	18.30	41	7.47	3.9	66.01	i.d.
413615	36.63	+	16.23	7.8	6.68	2.1	62.51	i.d.
683089	42.34	i.d.	13.69	26	6.60	14	65.12	i.d.
413011	38.63	84	16.43	14	6.88	13	64.43	56
413010	36.63	17	16.23	8.9	6.68	6.9	62.51	13
413614	34.64	i.d.	16.46	8.4	6.21	2.9	60.25	i.d.
413625	42.34	+	13.69	0.0	6.60	0.0	65.12	i.d.
683090	42.34	i.d.	13.69	0.0	6.60	0.0	65.12	i.d.
463001	30.66	57	16.48	1.4	5.54	0.0	56.06	32
				1977				
413616	17.72	29	45.61	72	8.40	27	72.83	55
413615	15.85	28	44.48	36	10.22	23	72.33	33++
683089	14.71	46	46.30	27	9.68	11	72.60	28
413011	14.86	23	46.20	25	9.86	i.d.	73.94	i.d.
413010	15.85	14	44.48	14	10.22	6.1	72.33	13
413634	14.83	1.5	41.89	5.8	11.70	5.8	70.28	4.7
413614	16.04	8.8	46.32	9.9	10.08	24	74.76	11
413625	14.71	6.5	46.30	0.7	9.68	1.0	72.60	1.9
683090	14.71	2.6	46.30	0.8	9.68	3.1	72.60	1.5
463001	17.22	i.d.	46.43	2.8	10.29	6.5	75.57	i.d.

*Average of all USGS rain gauges in the vicinity of the site.
**Includes precipitation in winter.
+Not operational.
++Includes snowmelt in winter.
i.d. Data insufficient for determination of runoff.

Table II-A-66. Effect of frequency of rainfall (days since last rainfall) on event loads at the predominantly single land use monitoring sites

Date	Frequency, days	Runoff, cm	Load, g/ha			
			Sus. solids	Total P	Soluble P	Pb
			413615			
760805	6	0.066	506	1.16	0.15	1.76
770211	1	0.183	1,220	11.33	5.77	16.34
770212	1	0.135	334	7.89	4.38	6.66
770303	8	0.824	10,728	48.68	16.75	61.91
770402	4	0.083	1,804	1.70	0.13	8.49
770424	3	0.063	837	1.44	0.01	4.26
770504	10	0.028	278	1.24	0.25	1.97
770605	0	0.392	41,751	31.38	0.63	187.53
770630	2	0.452	7,135	6.37	0.95	23.38
770816	3	0.926	7,857	12.15	1.37	36.87
770901	4	0.043	448	0.99		4.19
			683089			
760728	28	0.498	4,417	10.92	0.51	15.58
770402	4	0.396	18,464	11.07	0.47	36.09
770405	1	0.050	262	0.41	0.05	1.15
770605	5	0.387	12,773	10.41	0.65	20.13
770617	6	0.594	9,844	11.05	1.93	15.76
770628	11	0.222	5,881	7.14	0.40	9.32
770630	2	0.795	7,548	6.86	1.86	13.80
770724	4	0.537	4,270	2.56	0.12	11.82
770802	9	0.129	3,447	4.73	0.08	6.97
770901	4	0.325	1,598	3.19		8.90
770917	2	0.251	2,468	3.14		12.79
			413010			
760224	8	0.160	564	2.63	1.40	
760304	9	1.452	20,094	50.50	10.13	
760515	5	0.228	2,728	8.33	1.80	
760618	5	0.188	11,786	13.25	2.71	
760728	31	0.048	1,988	5.72	0.05	
760828	3	0.211	14,308	21.58	0.30	
760909	8	0.348	13,222	17.58	1.18	
770720	3	0.086	1,357	2.77	0.38	1.83
770803	1	0.179	6,439	8.30	0.46	5.02
770813	4	0.555	27,176	31.63	4.06	25.18
			413011			
760825	20	0.082	522	1.63	0.32	
760828	3	0.251	10,204	9.80	0.66	
760919	10	0.143	1,396	3.12	0.43	
761004	15	0.608	2,395	12.78	2.98	
770402	5	0.446	15,746	2.82	0.51	0.62
770504	10	0.032	79	0.21	0.01	0.07
770608	3	0.178	1,015	2.37	0.45	0.49
770610	2	1.525	70,423	86.83	6.13	53.99
770630	3	0.196	1,424	1.75	0.40	0.96
770716	10	2.090	61,187	68.05	6.65	
770720	4	0.040	94	0.47	0.11	0.30
770878	7	1.224	19,433	26.91	7.22	7.28
			413616			
761004	15	0.140	2,346	16.57	3.27	13.17
770402	3	0.118	690	8.25	2.81	1.63
770404	2	0.220	848	14.52	5.50	2.06
770420	16	0.148	10,209	34.97	6.38	41.75
770628	11	0.976	13,787	60.91	24.59	49.53
770724	3	0.521	16,152	54.29	26.78	40.39
770805	1	0.590	21,215	38.66	8.78	77.76
770912	8	0.375	447	30.51		16.52
			463001			
760218	6	1.291	2,756	12.36	7.68	
760225	7	1.732	6,644	36.56	16.64	
760302	6	3.102	69,696	123.39	36.43	
760311	5	2.011	38,169	39.71	14.83	
760424	9	2.292	59,732	133.29	8.91	
760730	2	0.160	4,290	6.39	0.71	
770610	2	0.310	[illegible]2,132	32.12	3.36	0.65
770720	2	0.006	33	0.12	0.05	0.03
770803	10	0.280	11,358	25.60	6.37	1.71
770813	10	0.031	473	1.10	0.73	0.18

Blank indicates that parameter was not analyzed.

Table II-A-67. Regression equation and correlation coefficients (r) of rainfall frequency with runoff and load of selected parameters at the predominantly single land use monitoring sites

Parameter	Regression equation	r-value	n*
	Station 413615		
Runoff	Y = 0.300 - 0.0025X	-0.024	11
Suspended solids	= 12,048 - 1420X	-0.359	11
Total P	= 10.6 + 0.184X	0.037	11
Soluble P	= 1.50 + 0.404X	0.253	10
Pb	= 55.3 - 6.06X	-0.342	11
	Station 683089		
Runoff	Y = 0.365 + 0.0023X	0.079	11
Suspended solids	= 6,815 - 52.5X	-0.074	11
Total P	= 4.84 + 0.240X	0.464	11
Soluble P	= 0.773 - 0.0127X	-0.144	9
Pb	= 13.5 + 0.0448X	0.038	11
	Station 413010		
Runoff	Y = 0.374 - 0.004X	-0.082	10
Suspended solids	= 12,059 - 272X	-0.260	10
Total P	= 17.9 - 0.212X	-0.120	10
Soluble P	= 2.46 - 0.0277X	-0.078	10
	Station 413011		
Runoff	Y = 0.634 - 0.0087X	-0.071	12
Suspended solids	= 23,049 - 1,007X	-0.228	12
Total P	= 24.9 - 0.892X	-0.171	12
Soluble P	= 2.86 - 0.0588X	-0.117	12
Pb	= 23.7 - 3.01X	-0.422	7
	Station 413616		
Runoff	Y = 0.433 - 0.0064X	-0.129	8
Suspended solids	= 9,876 - 226X	-0.165	8
Total P	= 30.3 + 0.275X	0.088	8
Soluble P	= 12.3 - 0.154X	-0.098	7
Pb	= 31.5 - 0.158X	-0.036	8
	Station 463001		
Runoff	Y = 0.663 + 0.0777X	0.221	10
Suspended solids	= 14,343 + 1,218X	0.151	10
Total P	= 15.7 + 4.29X	0.283	10
Soluble P	= 6.40 + 0.529X	0.151	10

*Number of events.

Table II-A-68. Relationships of water and parameter load during events at selected dates and stations*

Parameter	Cumulative load, %									Total**
683089 (770605)										
Water	10	20	30	40	50	60	70	80	90	38.7
Suspended solids	20	38	50	61	73	81	87	91	96	12,773
Total P	15	30	40	50	60	70	78	86	96	10.4
Pb	17	34	44	55	66	75	83	89	95	20.1
Soluble P	8	15	22	29	37	49	60	71	83	0.65
683089 (770617)										
Water	10	20	30	40	50	60	70	80	90	59.4
Suspended solids	23	39	56	67	78	87	93	96	98	9,844
Total P	15	26	39	47	55	63	70	77	85	11.0
Pb	25	42	64	75	86	92	96	97	99	15.8
Soluble P	10	18	26	30	35	39	43	51	65	1.93
683089 (770628)										
Water	10	20	30	40	50	60	70	80	90	22.2
Suspended solids	25	43	55	69	82	92	94	96	99	5,881
Total P	22	38	49	62	74	84	88	91	96	7.14
Pb	26	45	57	71	85	94	95	97	99	9.32
Soluble P	4	10	15	22	33	46	58	67	82	0.40
683089 (770630)										
Water	10	20	30	40	50	60	70	80	90	79.5
Suspended solids	16	34	45	56	66	76	83	91	96	7,548
Total P	15	30	38	48	57	66	72	81	89	6.86
Pb	15	28	37	50	64	71	75	80	83	13.8
Soluble P	8	17	23	31	39	49	58	71	81	1.86
683089 (770724)										
Water	10	20	30	40	50	60	70	80	90	53.7
Suspended solids	11	25	35	48	59	68	77	86	96	4,270
Total P	14	29	39	50	60	68	76	83	93	2.56
Pb	12	27	37	49	59	68	76	86	96	11.8
Soluble P	7	17	25	35	44	53	61	71	86	0.12
683089 (770917)										
Water	10	20	30	40	50	60	70	80	90	25.1
Suspended solids	20	37	52	67	80	89	92	95	98	2,468
Total P	15	28	41	56	66	77	82	89	94	3.14
Pb	17	30	44	57	69	80	85	91	96	12.8
413614 (770617)										
Water	10	20	30	40	50	60	70	80	90	18.0
Suspended solids	10	20	49	68	59	87	90	93	97	2,192
Total P	9	22	38	52	63	72	80	86	93	2.53
Pb	13	32	53	71	81	87	90	93	97	0.49
Soluble P	8	16	24	33	40	51	64	74	82	0.29
413614 (770630)										
Water	10	20	30	40	50	60	70	80	90	6.86
Suspended solids	13	26	36	45	57	66	77	84	93	387
Total P	17	35	46	54	66	74	84	89	96	0.48
Pb	13	29	40	50	52	62	75	83	94	0.86
Soluble P	8	19	27	37	62	70	80	86	94	0.09
413614 (770724)										
Water	10	20	30	40	50	60	70	80	90	7.78
Suspended solids	11	24	33	45	58	69	81	90	96	684
Total P	18	34	43	54	64	72	80	88	95	0.94
Pb	12	25	34	46	58	69	80	89	95	1.31
Soluble P	11	23	30	38	46	53	62	72	82	0.12
413625 (770605)										
Water	10	20	30	40	50	60	70	80	90	0.71
Suspended solids	1	2	7	15	27	38	51	65	80	321
Total P	4	8	17	25	37	48	59	71	84	0.45
Pb	1	3	8	17	31	43	55	68	83	0.16
Soluble P	8	17	32	42	54	64	73	82	91	0.09
413625 (770630)										
Water	10	20	30	40	50	60	70	80	90	2.87
Suspended solids	7	17	32	48	60	70	81	90	96	1,136
Total P	7	16	30	45	57	67	78	86	93	1.14
Pb	6	14	27	42	54	65	76	85	92	0.55
Soluble P	5	13	25	39	52	62	73	82	90	0.23
413625 (770813)										
Water	10	20	30	40	50	60	70	80	90	3.32
Suspended solids	10	27	51	71	83	89	94	97	99	2,675
Total P	11	24	43	59	71	77	85	91	96	1.87
Pb	16	31	49	64	75	81	88	92	97	0.92
Soluble P	11	21	32	42	51	59	69	79	90	0.29
413625 (770924)										
Water	10	20	30	40	50	60	70	80	90	7.12
Suspended solids	16	33	53	68	80	88	93	97	99	4,580
Total P	12	25	40	54	68	79	85	91	96	3.93
Pb	17	32	47	61	74	83	89	94	97	2.14
683090 (770813)										
Water	10	20	30	40	50	60	70	80	90	0.95
Suspended solids	9	21	35	50	58	72	81	88	93	29.7
Total P	6	13	22	33	40	54	66	78	88	0.53
Pb	6	12	20	29	36	49	62	70	86	0.08
Soluble P	11	22	36	50	57	68	78	86	92	0.38
683090 (770924)										
Water	10	20	30	40	50	60	70	80	90	16.2
Suspended solids	10	27	48	64	73	84	95	99	100	472
Total P	10	19	30	41	48	58	72	81	91	7.12
Pb	12	21	31	41	47	58	72	81	91	1.18

*See Table II-A-64 for total rainfall data for most of the selected events.

**Total parameter load is in g/ha except water load which is in m^3/ha ($m^3/ha \times 0.01 = cm$).

PART III

THE BENTHIC MACROINVERTEBRATES OF THE MENOMONEE RIVER

by

B. ABRAMS
G. CHESTERS

ABSTRACT

The impact of agricultural and urban pollution from non-point sources on benthic macroinvertebrate communities in the Menomonee River is evaluated utilizing biological monitoring data collected by the Wisconsin Department of Natural Resources (1951 to 1968) and University of Wisconsin Water Resources Center (1975 to 1976).

Non-point pollution from agricultural areas in the headwaters of the Menomonee River and point source pollution from industrial and commercial areas mask any effects caused by pollutant-loadings attributable to urban non-point sources. The diversity (genera level) and biotic indices can locate areas of disturbance but cannot differentiate specific impacts of major land use categories on macroinvertebrate communities. Due to the relative intensity of the calculated indices, similar values are obtained for the moderately polluted agricultural and urban areas even though the macroinvertebrate genera may be different.

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III-1. INTRODUCTION

The benthic macroinvertebrate community of the Menomonee River and its tributaries was sampled by the Wisconsin Department of Natural Resources (WDNR) from 1951 to 1968 (1 to 4). In 1975, the University of Wisconsin Water Resources Center assumed responsibility for the biological monitoring as part of the IJC-Menomonee River Pilot Watershed Study. This report summarizes the earlier WDNR findings and examines the effect of agricultural and urban pollution fromnon-point sources on aquatic macroinvertebrate populations.

The Menomonee River Watershed is a surface water drainage unit, 352 km^2 in areal extent, located in the southeastern corner of Wisconsin (Fig. III-1). The Menomonee River has its source in a woodland-wetland area located in the northeastern corner of the Watershed in the Village of Germantown. The river flows in a southeasterly direction for approximately 47 km and discharges to the Milwaukee River at the City of Milwaukee. Approximately 26 km downstream from the headwaters, the Menomonee River is joined by the Little Menomonee River. The Little Menomonee River flows in a southerly direction for 16 km before its confluence with the Menomonee River. Other principal tributaries in the Watershed are Noyes, Underwood and Honey Creeks.

The average flow (1975 and 1976) upstream at Germantown was 0.43 m^3/sec, the headwaters of the Little Menomonee at Donges Bay (STORET Station No. 463001) averaged 0.18 m^3/sec and past the confluence, at 70th Street (413005), the flow averaged 2.82 m^3/sec (Table III-1).

Urbanization generally increases from the north to the south of the Watershed. Existing urban land uses range from an intensely-developed commercial/industrial complex in the lower quarter of the Watershed (City of Milwaukee) to low-medium density residential areas in the center half while the upper quarter is in the process of conversion from rural to urban. Noyes Creek (413011), is an example of a rapidly urbanizing area.

The biological stations were arranged according to increasing urbanization based upon 1975 land use data (5; Table III-1 and Fig. III-2). Each land use analysis included the total drainage basin of the station assuming all land above a station will affect the water quality of the site. Therefore, at 413005 the land use computation included the upper rural portion of the Watershed although the biological community was predominantly affected by the immediate surroundings (72% urban).

A rather large portion of the stream system has been altered for flood purposes (Fig. III-1). In 1974, 67% of the perennial and intermittent streams in the Watershed had undergone channel modification (6). Most of the modification has been minor channelization consisting of localized clearing

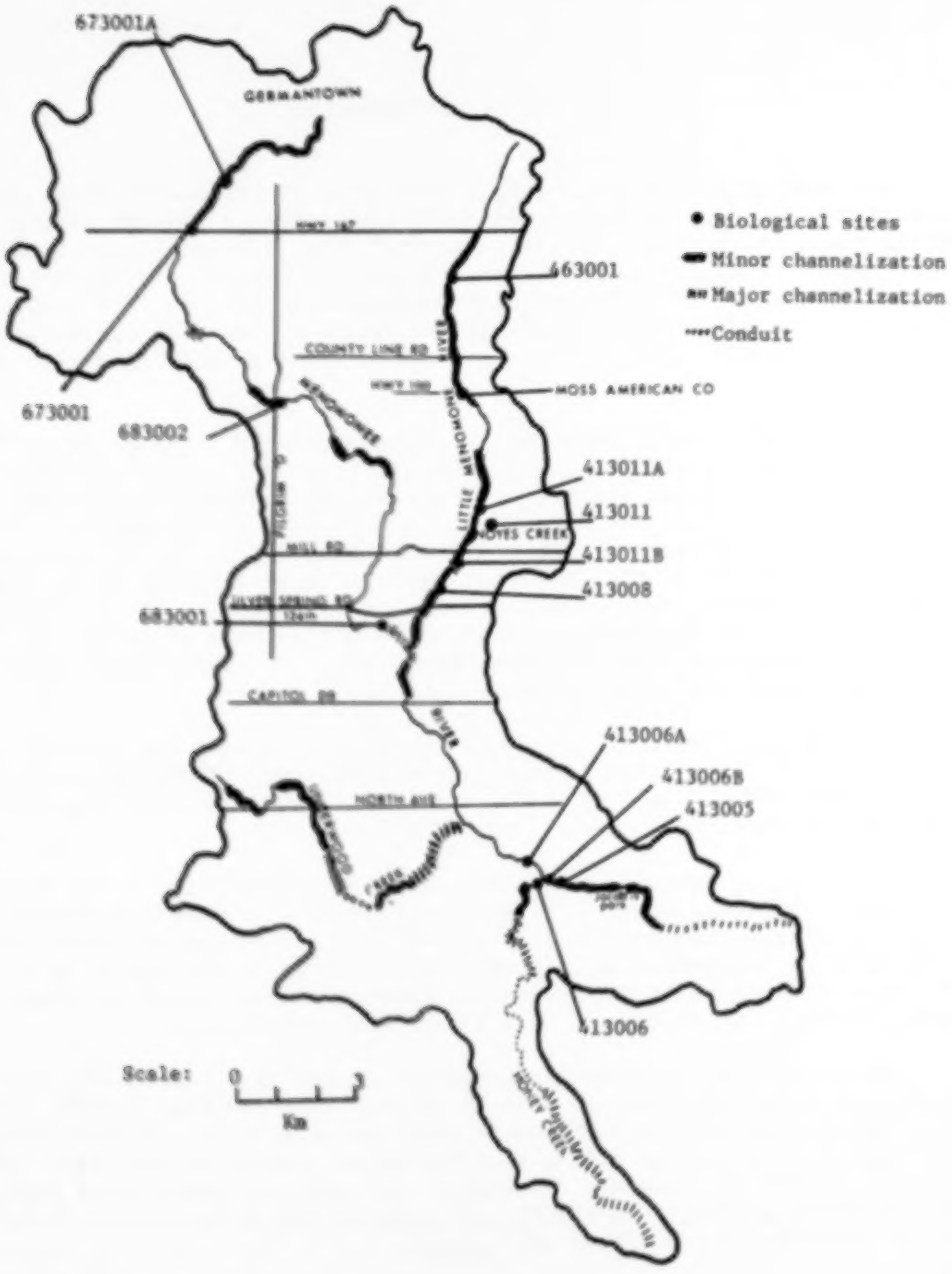
673001A
GERMANTOWN
HWY 167
● Biological sites
▬ Minor channelization
▪▪ Major channelization
┅ Conduit
663001
COUNTY LINE RD
RIVER
HWY 100
MOSS AMERICAN CO
673001
683002
MENOMONEE
PILGRIM RD
LITTLE MENOMONEE
413011A
413011
NOYES CREEK
MILL RD
413011B
413008
SILVER SPRING RD
124th
683001
CAPITOL DR
RIVER
413006A
413006B
413005
NORTH AVE
UNDERWOOD
CREEK
413006
HONEY CREEK
Scale:
0
3
Km

Fig. III-1. The Menomonee River Watershed showing biological monitoring sites and modification of the river channel.

Table III-1. Station description

Site number	Location	Average flow,* m^3/sec	Total drainage area, km^2	Substrate, (%)**			Land use adjacent to station
				Silt	Sand	Gravel	
463001	Donges Bay Road	0.18	20.5	5	40	55	Rural, 64% row crops
673001	Riverlane Road	0.43	48.7	2	30	68	Rural (agricultural), golf course
683002	Pilgrim Road, Hwy. YY	0.79	89.4	2	32	66	Suburban area, 50% row crops
683001	124th Street	1.55	157.0	24	35	41	Rural to urban transition
413008	Appleton Avenue, Hwy. 175	0.48	131.6	16	76	8	Rural to urban transition, creosote contamination
413005	70th Street Bridge	2.82	318.6	#	#	#	Industrial, residential
413011	Noyes Creek	0.05	5.2	#	#	#	Industrial, residential
413006	Honey Creek	0.25	26.7	0	0	100	Industrial, residential

*1975-1976.
**USGS September 1976; silt + clay = < 0.062 mm; sand = 0.062 mm to 2.00 mm; gravel = > 2.00 mm to 16.0 mm.
#No data available.

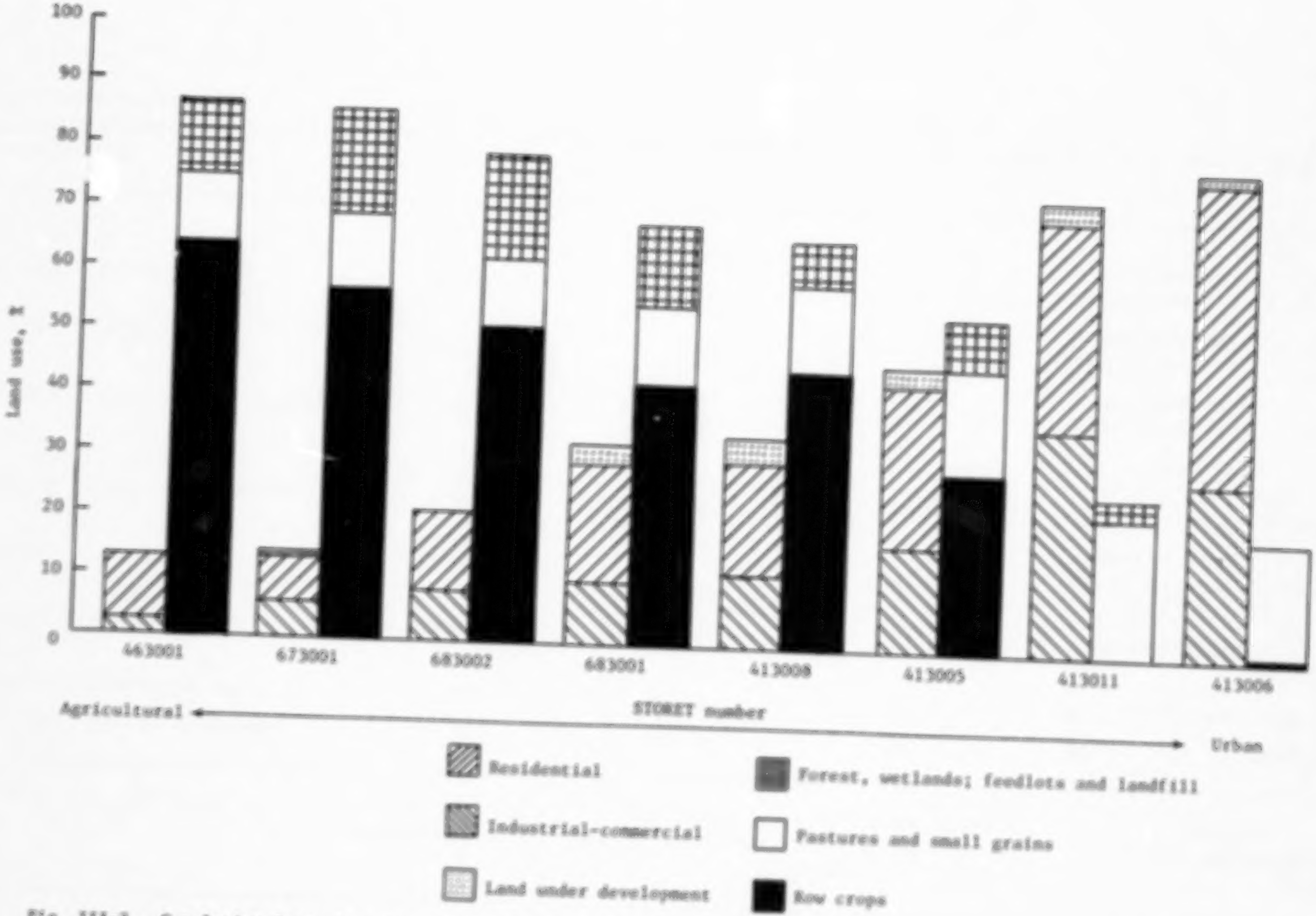

Fig. III-2. Cumulative land use categories adjacent to biological stations.

and widening with scattered straightening. Only limited areas underwent major channelization where extensive concrete or masonry was added to the deepened, widened or straightened river. A conduit completely eliminated the natural channel of a 3.7 km reach of Honey Creek (6).

Creosote pollution has been a problem in the Little Menomonee River since the 1920's. Patchy deposits of the toxic hydrocarbon mixture are found in the sediments from below the Moss American Railroad Tie Treating Company to the confluence with the mainstem (7).

The stream bed substrate varies depending on the season and flow, but generally it is sand and gravel (Table III-1). A layer of creosote-free silt, sand, and detritus was found overlying the contaminated sediments of the Little Menomonee (7).

III-2. CONCLUSIONS

Since macroinvertebrates were only identified to the genera level and chironomids, oligochaetes and gastropods were treated as three groups the sensitivity of the indices was impaired. However, even if taxonomic identification had been performed to species level, relative ratings of the stations would likely not be changed.

Environmental factors that influence community structure cannot be disregarded. The physical effect of high currents on the benthic organisms cannot be separated from the pollutional load. One cannot say if a material will be harmful by its concentration alone. The effect of toxic substances on the biota in the aquatic ecosystem depends not only on the concentration of the toxicants but also on exposure time, environmental characteristics of the receiving system, age and condition of the organisms and presence of other toxicants (8).

The pollution from non-point sources from agricultural areas in the headwaters of the Menomonee River and the point source pollution from industrial and commercial areas of the Watershed are so large that they mask any effects caused by the loadings attributable to urban non-point sources. The diversity and biotic indices can locate areas of disturbance but cannot differentiate specific impacts of major land use categories on macroinvertebrate communities. Due to the relative insensitivity of the calculation of indices, values obtained in moderately polluted agricultural areas are similar to those values for areas with moderate urban pollution even though the macroinvertebrate genera may be different.

III-3. MACROINVERTEBRATES AND WATER QUALITY

Stream macroinvertebrates spend all or part of their life associated with the water and substrate. Their distribution is naturally regulated by speed of the current, temperature, seasonal changes, substrate characteristics, dissolved substances, food and competition and can be altered indirectly by man's activities on land or directly by channelization and dredging (9). Replacement of native plants by agricultural crops alters the amount of sediment and nutrients entering the system. In the urban environment, impervious surfaces cause other non-point pollution problems.

Macroinvertebrates are sensitive to water quality and because of their relative immobility have been used as indicators (10). Species vary depending on the types and concentrations of pollutants they tolerate. Some organisms are unable to exist when a slight change in the aquatic environment occurs. If the intolerant forms are reduced or eliminated an increase in the more tolerant organisms often occurs due to reduced predation and competition. In harsh environments only very tolerant organisms will survive. A clean water community usually is balanced, meaning it is composed of many species with a few individuals in each; this balance is changed by pollution.

Macroinvertebrate Sampling in the Menomonee River Watershed from 1951 to 1975

A sampling program, in July 1951, indicated that a polluted condition existed below the Rockfield Cannery near the headwaters of the Menomonee River. The population of sludge worms and leeches likely was caused by the company's discharge of waste material into the river. One mile below the sewage treatment plant serving the Village of Germantown, the macroinvertebrate community was typical of a highly polluted river system (1).

During sampling programs in May and July of 1953, the Menomonee River from 124th Street to Capital Drive was found to support a clean water benthic community. Near North Avenue--located below three combined sewer overflow devices--it was evident that the biological community had been affected by pollution. The biological communities in the Little Menomonee River at County Line Road and at Highway 100 (Fig. III-1) suffered from high levels of suspended solids arising from current topsoil removal. At County Line Road the macroinvertebrate population was small and at Highway 100 only pollutant-tolerant sludge worms lived in the oil- and tar-contaminated bottom muds. The sample from Honey Creek at 84th Street and Honey Creek Parkway indicated polluted conditions. An appropriate upstream station could not be found due to dredging, concrete or hard clay bottom (2).

In March and April of 1968 samples at 124th Street on the Menomonee River indicated a balanced macroinvertebrate community; downstream the community structure was unbalanced. Above the Moss American Company, on the Little Menomonee River, the benthic community was balanced but polluted conditions were found below the industrial site to the confluence with the main stem.

In October 1966, a sampling program indicated a balanced community in the upper Menomonee River. Below the Gehl Guernsey Farms, Inc. milk condensing plant waste outfall and the Germantown sewage treatment plant outfall, an unbalanced community existed. Above the Menomonee Falls sewage treatment plant--at Pilgrim Road--clean water conditions supported a well-balanced benthic community. Below the point source there was a marked increase in sludge worms, snails and bloodworms indicating partially polluted conditions. Downstream--at Mill Road--a clean water benthic community indicated a recovery zone (3).

In October 1971 a qualitative study of the Little Menomonee River was conducted and revealed varying degrees of pollution from below the Moss American Company to the confluence with the Menomonee River (4).

In October 1975 a qualitative Surber benthic survey from the Menomonee River indicated a relatively balanced benthic community from Friestadt Road to Pilgrim Road, while samples from Currie Park and further downstream were extremely unbalanced. Quantitative sampling was performed at Silver Spring Road, Jacobus Park and Mill Road (Little Menomonee River). At all three sites oligochaetes comprised > 50% of the population. At Silver Spring Road the remainder of the community was composed of *Cheumatopsyche* and Chironomids. *Ascellus* dominated the sample at Mill Road indicating an area high in organic debris (11). Jacobus Park exhibited a reduced population of Chironomids and Gastropods (Tables III-A-1 and III-A-2 in the Appendix).

In general, the early studies describe a partially polluted stream with occasional areas of recovery (12).

Recent Macroinvertebrate Sampling in the Menomonee River Watershed

The macroinvertebrate community was used to examine the impact of land use on the biological community of the Menomonee River from May to August of 1976 (13). Five sites were selected for biological monitoring of which four coincided with continuous monitoring stations nos. 413005, 683001, 413008 and 673001 and an additional upstream site No. 683002 (Fig. III-1). To allow uniformity between sites each station was equipped with a floating structure on which six modified Hester-Dendy artifical substrate samplers were suspended.

These samples were supplemented by Surber samples--samples containing organisms collected directly from the substrate--because of vandalism and *Chironomidae* colonization of the Hester-Dendy samplers. One hundred organisms were subsampled to represent the sample population (TablesIII-B-1 and

III-B-2). A biotic index (14) was used to assess the water quality at each station due to the subjective nature of classifying organisms into tolerance categories. Organisms were assigned index values based on an assessment of the organisms ability to withstand varying degrees of pollution. Organisms found only in clean water received low values while organisms found in polluted waters were assigned high values. An average quality value or biotic index (BI) was calculated for the sampled site by multiplying the number of organisms in each species or genera "a" by its index value and continuing for all genera in the sample. If careful attention has been given to the assignment of index values, the biotic index will not be greatly affected by sample size. The biotic index was calculated from:

$$BI = \frac{n_i a_i}{N} \qquad \text{Eq. (1)}$$

where n_i is the number of individuals in each genus, a_i is the index value for that genus (Table III-2) and N is the total number of individuals in the samples (14). All aquatic organisms belonging to the class *Insecta* and orders *Isopoda* and *Amphipoda* were identified to genera with the exception of the *Chironomidae*. Due to time limitations only random chironomids were selected for generic identification. For site nos. 413005, 683001, 413008 and 683002 most of the *Chironomidae* were *Cryptochironomus* and *Cricotopus*. The *Chironomidae* at these stations were considered a single taxon and assigned a BI value of 3.5. At station 683002 the majority of the *Chironomidae* were *Chironomus* and *Glyptotendipes* and were given a BI value of 5 (13).

The biotic index values, ranging from 0 to 5, can be used to evaluate water quality and stream conditions. When the biotic index value is < 1.75, water quality is considered excellent and the stream undisturbed. Values of 1.75 to 2.25 indicate good water quality and some enrichment. Fair water quality is indicated by biotic index values of 2.25 to 3.00. A stream with significant enrichment or disturbance and poor water quality has ratings of 3.00 to 3.75. If values are greater than 3.75, gross disturbance and very poor conditions prevail (14).

Biotic index values for both artificial substrates and Surber samples are indicative of a disturbed stream (Table III-3). Sites 673001 and 413008 fall into the grossly disturbed category. The magnitude of disturbance at 673001 is further indicated by the high number of organisms (Table III-4), particularly *Glyptotendipes*, a chironomid with the special ability to survive at low oxygen concentrations. These conditions were attributed to nutrient loadings from the fertilized cropland and golf course immediately above the location (13). The very low numbers of macroinvertebrates at 413008 most likely resulted from toxic creosote deposits in the bottom sediments of the Little Menomonee River.

To simplify the complex interface between land use and water quality, the biological program was continued by studying sites in smaller, more contained areas of known land use. In an attempt to find a more sensitive

Table III-2. Biotic index values of organisms found in the Menomonee River

Macroinvertebrate	Value*	Macroinvertebrate	Value*
Ephemeroptera		Coleoptera	
Caenis	4	*Agabus*	1
Baetis	3	*Dubiraphia*	3
Stenacron	3	*Optioservus*	2
		Stenelmis	3
Tricoptera			
Cheumatopsyche	4	Decopoda	3
Pycnopsyche	1		
Hydroptilidae	3	Oligochaeta	5
Hydropsyche	3		
		Isopoda	
Diptera		*Asellus*	5
Stillobezzia	3		
Bezzia	3	Amphipoda	
Simulium	3	*Hyalella*	4
Limonia	2		
Ephydridac	4	Gastropoda	
Chironomidae	3 to 5	*Physa*	4
Turbellaria		Hirudina	4
Dugesia	3		
		Pelecypoda	
		Pisidium	4

*Estimated from Hilsenhoff (14) and Weber (15) macroinvertebrate tolerance classification.

Table III-3. Average biotic index value at sampling stations (May to August 1976)

Site number	Dendy samples	Surber samples
413005	3.50	3.46
683001	3.50	3.48
413008	3.86	*
683002	3.60	3.38
673001	4.48	4.50

*No samples taken at this station.

Table III-4. Approximate number of organisms that colonized Hester-Dendy substrates in 1976

	Site no.				
Date	413005	683001	413008	683002	673001
5/21			28		73
6/4			42		392
6/18			112		1,000
7/2	250		121		700
7/16	142		66		500
7/30	87		7		1,990
8/13	102	102	12	151	10,000

index summarizing community structure the information theory index of diversity, suggested by Weber (15), was used:

$$\bar{d} = \frac{C}{N} (N \log_{10} N - \Sigma n_i \log_{10} n_i) \qquad \text{Eq. (2)}$$

where C = 3.321928 (converts base 10 log to base 2 log); N is total number of individuals; and n_i is total number of individuals in the i^{th} species. Wilhm (17) suggested index values > 3 to indicate unpolluted water and values < 1 to indicate pollution. Diversity indices, describing macroinvertebrate community structure, have been used to locate municipal-industrial point sources of pollution (10). Gislason (18) used the diversity index to define areas with point and non-point urban pollution and heavy agricultural pesticide inputs. The goal of this project was to determine the effects of non-point sources of pollution from individual land uses in the Menomonee River Watershed on the macroinvertebrate communities.

Sampling Periods and Locations

During November 8 and 9, 1976 Surber samplers were used to collect macroinvertebrates in riffle areas at station nos. 463001, 413001, 413011, 413011A and 413011B, 413006, 413006A and 413006B and 413005 ("A" indicates a site above a water quality monitoring station, "B" refers to one below). Sites were selected with a gradient of land uses ranging from 86% agricultural land at site 463001 to 20% at site 413005.

At each sampling site, temperature, dissolved oxygen, current, depth and stream width were recorded. Samples were preserved in 70% ethanol and hand-picked using rose bengal stain to aid in differentiating the organisms from detritus.

The Little Menomonee River agricultural sampling station (463001) had the highest diversity value (Table III-5). Based on the classification scheme proposed by Wilhm (17) this is the only site that can be considered clean. The community at the next station 413011A, consisted of 90% oligochaetes likely due to the patchy creosote deposits in the bottom sediment. In 1973, an attempt was made to remove the creosote-contaminated bottom sediment from the river reach between station 413011A to slightly upstream of station 413011B. According to the U.S. EPA (7) the project was not completely successful and the creosote deposits could be the reason for the low diversity index value. The increase in diversity further downstream, at station 413011B, indicates possible recovery but all stations--agricultural and urban--showed values indicative of moderate pollution. The exception was the urban station no. 413006B with a value of < 1. A general decrease in the number of macroinvertebrates is evident towards the urban area except for the two tributaries, Noyes and Honey Creeks (Table III-5). Noyes Creek Station (413011) contained an extremely high number of isopods (Fig. III-3 and Table III-C-1). This phenomenon has been associated with high organic matter

Table III-5. Diversity and biotic index values for Menomonee River Watershed sampling stations (listed in order of increasing urbanization)

Site number	Location	Urban: Agriculture Ratio	November 1976			May 1977			
			Mean Number of Organisms/Sample	Total Taxa	Diversity Index	Mean Number of Organisms/Sample	Total Taxa	Diversity Index	Biotic Index
	Agricultural								
673001A	Freistadt Road and STH 145	14:86	**	**	**	503	19	2.50	3.83
673001	Riverlane Road Hwy F	14:86	**	**	**	538	15	2.27	4.24
463001	Donges Bay Road*	14:86	540	22	3.30	261	13	1.50	3.83
413011A	91st and Goodhope Road*	20:80	257	11	0.81	183	5	1.20	3.75
413011B	Mill and Fond du Lac Ave.*	34:66	162	17	2.79	143	9	1.10	4.11
	Urban								
413006A	Above Honey Creek (November: 91 m May: 385 m)	72:28	125	5	1.31	55	2	0.13	4.70
413006B	Below Honey Creek (91 m)	72:28	71	3	0.66	38	3	1.30	4.70
413005	70th Street Bridge	72:28	103	6	1.49	20	3	1.20	4.50
413011	Noyes Creek*	74:26	635	13	2.07	44	5	0.60	4.06
413006	Honey Creek	80:20	364	8	1.37	0			

*Little Menomonee River
**Not sampled.

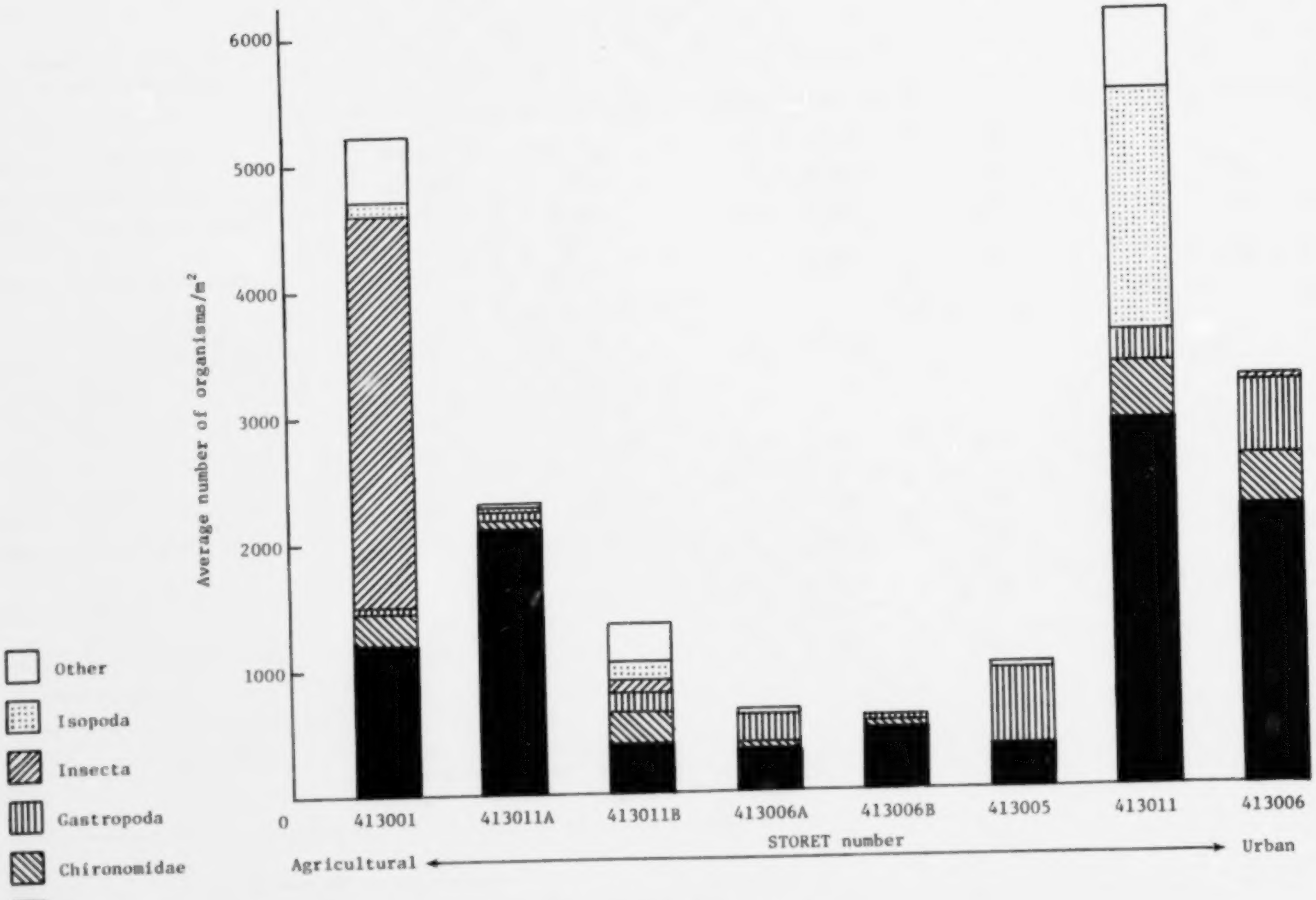

Fig. III-3. Composition of November 1976 Surber samples.

content and could be related to the sewage relief pump on the south branch of Noyes Creek. At the Honey Creek station (413006) the observed large population was due to the abundance of oligochaetes. Other than station 413011, in areas of the Watershed that were at least 70% urban and/or had a point source of pollution, the samples were predominantly oligochaetes, chironomids and gastropods (Fig. III-3).

The sampling scheme employed in November, 1976 was repeated on May 12 and 13, 1977 with two additional agricultural sites sampled on the Upper Menomonee River (673001A and 673001).

The greatest abundance of macroinvertebrates (Table III-5) as well as the highest diversity indices were observed at the northwest Menomonee River agricultural stations 673001A and 673001. According to the criteria proposed by Wihlm (17), these sites are rated as moderately polluted. The uppermost Station (673001A) supported *Baetis* and *Hydropsyche* (*Insecta*) and *Chironomidae* (Fig. III-4 and Table III-C-2). Below the golf course (673001), the community was predominantly *Simulium* and *Dugesia* (*Insecta*) and the pollutant tolerant chironomid, *Glyptotendipes*. Half the number of macroinvertebrates were found at the Little Menomonee River upstream agricultural station (463001) compared with the mainstem agricultural sites, but its diversity value still placed it in the moderately-polluted category (Table III-5). The data indicates that sites 413006 (macroinvertebrates absent), 413011 and 413006A are heavily polluted. The low diversity and faunal abundance at 413011 may be due to the unusually high temperature (27°C) caused by the concrete channelization preceding the station. The milky water at station 413006 at the time of sampling suggests a point source of industrial discharge. According to the biotic index values exceeding 3.75, all stations rated as grossly polluted.

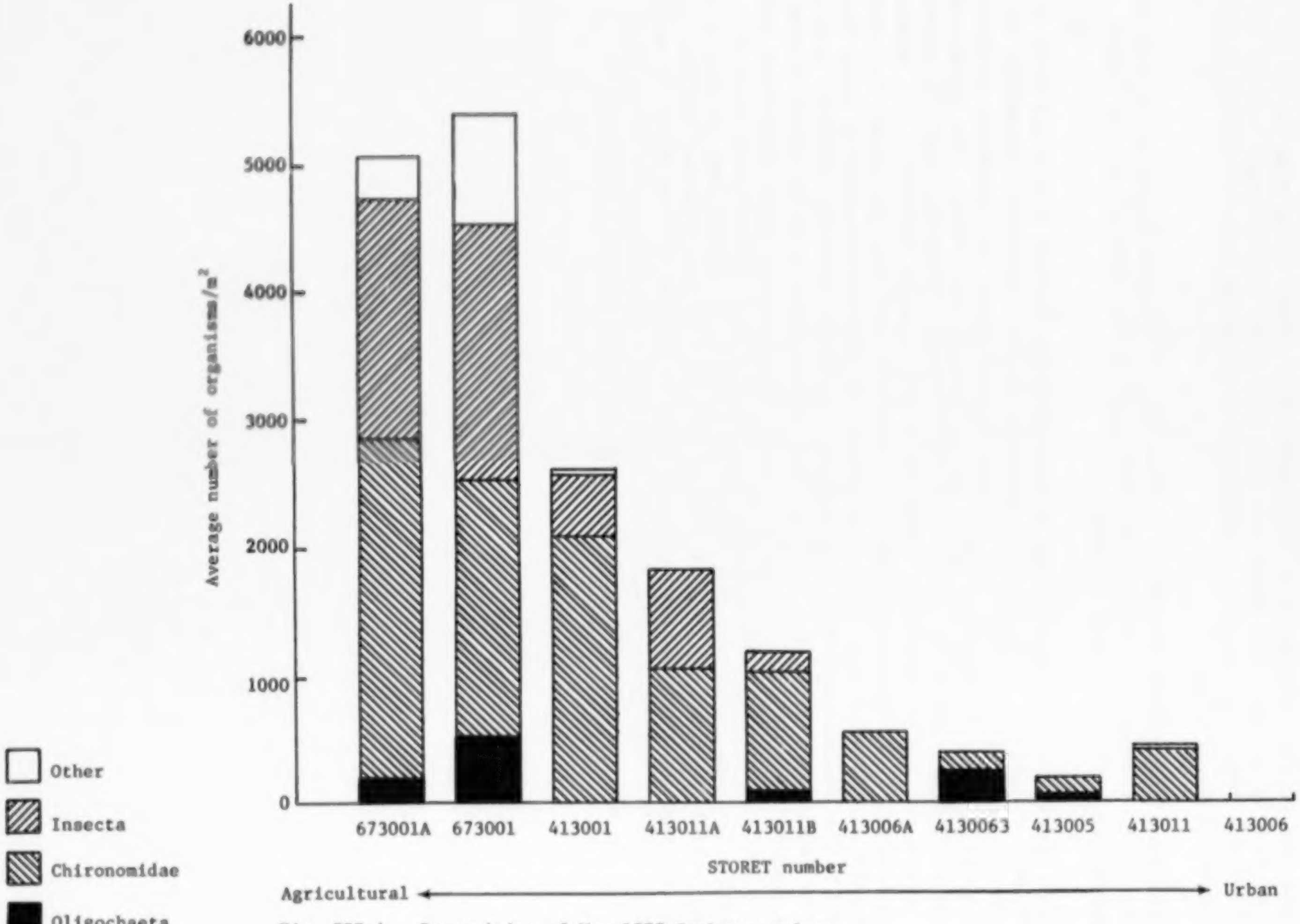

Fig. III-4. Composition of May 1977 Surber samples.

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APPENDIX A - SURBER SAMPLING IN 1975

Table III-A-1. Wisconsin DNR macroinvertebrate Surber samples taken in October 1975

	Location					
	Silver Spring Road		Mill Road Little Menomonee River		Jacobus Park	
Organism	No./m^2	%	No./m^2	%	No./m^2	%
Tricoptera						
Cheumatopsyche	7,190	14				
Hydropsyche	2,087	4	32	<1	*	
Hemiptera						
Saldidae					*	
Diptera						
Simulium	2,889	6	86	1	32	<1
Chironomidae	9,245	18	482	6	1,198	26
Empididae	86		43	<1	21	<1
Oligochaeta	29,393	57	4,901	63	2,333	51
Pelecypoda						
Sphaerium	54		342	4	32	<1
Coleoptera						
Stenelmis						
adult			*			
larvae	86		43	<1		
Optioservus			75	1		
Agabus					*	
Turbellaria						
Planariidae	321	1	64	1	11	<1
Isopoda						
Asellus			1,562	20	375	8
Ephemeroptera						
Baetis	139				*	
Tricorythodes	32					
Stenacron			11	<1		
Caenis			*			
Gastropoda						
Physa			54	<1	235	5
Ferrissia			96	1	278	6
Decapoda			*			
Hirudinea						
Helobdella			64	1	43	1
Piscicolidae					*	
Amphipoda						
Hyalella			*			
TOTAL	51,522	100	7,855	100	4,558	100

*Average <1%.

Table III-A-2. Chironomidae identification of Wisconsin DNR macroinvertebrate Surber samples in October 1975

Chironomidae	Silver Spring Road		Mill Road Little Menomonee River		Jacobus Park	
	No./m^2	%	No./m^2	%	No./m^2	%
Procladius	43	<1				
Pseudochironomus	803	9			64	5
Ablabesmyia						
Chryptochironomus	86	1	54	11	321	27
Conchapelopia	482	5	161	33	674	56
Cricotopus	5,671	62	182	37	11	
Rheotanytarsus	439	5	21	4		
Polypedium	1,124	12	11	2		
Chironomus	118	1	11	2		
Brillia			11	2		
Trichocladius			11	2		
Micropsecta			11	2	32	3
Guttipelopia						
Orthocladius	278	3				
Unidentified	96	1	11	2	96	8
TOTAL	9,140	100	484	97	1,198	100

APPENDIX B - NUMBER OF ORGANISMS COLLECTED FROM MAY TO AUGUST 1976

Table III-B-1. Percent distribution of organisms collected in Surber samples (July-August 1976)

STORET number	Date	Antocha	*Asellus*	Baetis	Berosus	*Bezzia*	Caenis	*Cheumatopsyche*	Chironomidae	Empididae	Ephemerella	Gammarus	*Hyalella*	*Hydropsyche*	Hydroptilidae	*Optioservus*	*Simulium*	*Stenacron*	*Stenelmis*	Stenonema
413005																				
	7/16								97						3					
	30		6			3			91											
	30		1						99											
	8/13								78						21					
	13								90	3					7					
	27		7						81	1					10		1			
	27								73	1					26					
683001																				
	7/16		2	8				29	1	1				55	4					
	30		4	7				37	3					42	7					
	8/13		45	26				5	12					12						
	13	4	3	18				18	7	1				42	7					
	27			11				36						48	4		1			
	27		2	27				44	2		1			19	4				1	
683002																				
	7/16		14	11				22						7				44	3	
	16		1	16				31	1					35			5	6	5	
	30		14	10				36	6	1				4				15	14	
	8/13		5	22				2	3					3	13			30	22	
	13			12				31	1					41	7		7	1		
	27		4	12				20	2					20	2		1	32	7	
	27			18				21	8					32	1			10	10	
673001																				
	7/16								99			1								
	30		4			1			95											
	8/13								100											
	8/27								99	1										

Table III-B-2. Percent distribution of organisms that colonized Hester-Dendy substrates (May-August 1976)

STORET number	Date	Antocha	*Asellus*	Baetis	Berosus	*Bezzia*	Caenis	*Cheumatopsyche*	Chironomidae	Empididae	Ephemerella	Gammarus	*Hyalella*	*Hydropsyche*	Hydroptilidae	*Optioservus*	*Simulium*	*Stenacron*	*Stenelmis*	Stenonema
413005																				
	7/2								100											
	2								100											
	16		1						99											
	16					1			99											
	30								100											
	30					1			99											
	8/13								100											
	13					1			98	1										
	27								98						2					
	27								99	1										
683001																				
	8/13								100											
	13								98					2						
	27								100											
	27								100											
413008																				
	5/21								100											
	21								100											
	6/4		56					2	42											
	4		57					3	31			3		3			3			
	18		8						92											
	18		9						91											
	7/2		55						45											
	2		32						68											
	16		85						15											
	16		42						58											
	30								100											
	30		5						95											
	8/13					10			90											
	13								100											
	27								100											
	27								100											
683002																				
	7/2		4	1				10	85											
	8/13		7	1	1			1	84									3	3	
	13		7			2		4	72									7	8	
	27		1						95						2				2	
	8/27		1			1			95						1				2	
673001																				
	5/21		2					2	96											
	21		1					1	97					1						
	6/4		15				2	9	72								2			
	4		15				6	6	72				1							
	18		8					1	91											
	18		15						85											
	7/2		4			2	1	3	90											
	2		5					1	94											
	16		1						99											
	16		1						99											
	30				1				98									1		
	30								99				1							
	8/13				1				99											
	13				1				99											
	27				4				95				1							
	27		1			1			95										3	

APPENDIX C - SURBER SAMPLING IN 1976 AND 1977

Table III-C-1. Average number of organisms collected in quadruplet Surber samples (November 8-9, 1976)

	Station							
Organism	463001	413011A	413011B	413006A	413006B	413005	413011	413006
Odonata								
Amphiagrion							43	
Diptera								
Bezzia								
Chironomidae	332	86	321	21	54	11	460	449
Chrysops	11							
Empididae								43
Ephydridae								
Erioptera								
Helius								
Limonia			11					
Simulium	11							
Stillobezzia							11	
Tipula	54	21						
Pelecoptera								
Allocapnia	43							
Ephemeroptera								
Stenacron	54							
Tricoptera								
Cheumatopsyche	439							
Hydropsyche	471							
Pycnopsyche							21	
Tricladia								
Dugesia	385	32	332					
Coleoptera								
Dubiraphia adult	54							
larvae	32							
Optioservus adult	203							
larvae	1,541		11					
Stenelmis adult	86							
larvae	460		54					
Ectopria	21							
Pelecopoda								
Sphaerium	11	21	139	21		32	364	
Decopoda								
Oligochaeta	1,338	2,472	503	728	663	396	3,178	2,632
Isopoda								
Asellus	86	32	171				2,087	
Amphipoda								
Hyalella							342	749
Gastropoda								
Physa	43	75	193	428	43	375	268	
Ferrisia		11		12		246		
Hidudina				11		43	21	21
Average number of organisms/m^2*	5,799	2,750	1,733	1,338	760	1,102	6,795	3,895
Number of taxa	22	12	17	6	3	7	13	8

*Computed on a metric basis although the Surber sampler collects organisms that colonize a one square foot area.

Table III-C-2. Average number of organisms collected in triplicate Surber samplers (May 13, 1977)

Organisms	Stations									
	673001A	673001	413001	413011A	413011B	413006A	413006B	413005	413011	413006
Diptera										
Bezzia	11	11								
Chronomidae	696	2,108	1,990	1,134	1,252	578	171	118	450	
Ephydridae					11					
Erioptera										
Simulium	268	1,926	407	770	139	11				
Stillobezzia										
Limonia	11									
Ephemeroptera										
Caenis		64								
Baetis	535		214	11						
Stenacron										
Tricoptera										
Cheumatopsyche	64									
Hydropsyche	728									
Hydroptilidae	161		32							
Pycnopsyche	21									
Tricladia										
Dugesia	75	503								
Coleoptera										
Berosus										
Dubiraphia	11									
Optioservus	21		21							
adult										
Larva	161	32	54							
Stenelmis										
Agabus			21							
Pelecypoda										
Sphaerium		21								
Pisidium										
Decopoda	21									
Oligochaeta	193	578	21	32	96		235	96		
Isopoda										
Asellus	246	492	32	11	11				11	
Amphipoda										
Hyallela										
Gastropoda										
Physa		21								
Hirudina					11					
Average number of organisms/m^2*	5,361	5,767	2,793	1,958	1,530	589	407	214	460	0
Number of taxa	19	14	13	5	9	2	4	3	5	0

*Computed on a metric basis although the Surber sampler collects organisms that colonize a one square foot area.